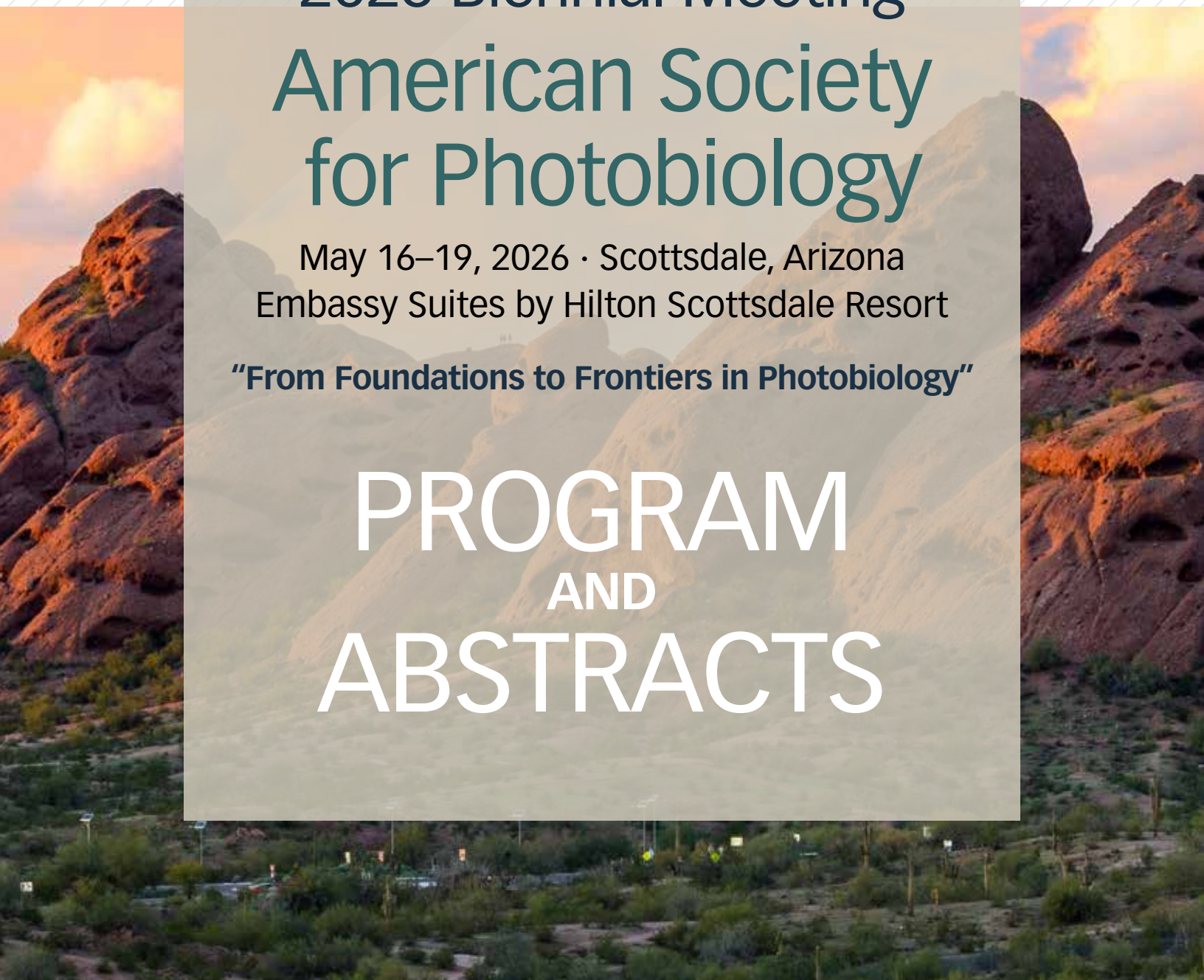

2026 Biennial Meeting

American Society for Photobiology

May 16–19, 2026 · Scottsdale, Arizona
Embassy Suites by Hilton Scottsdale Resort

"From Foundations to Frontiers in Photobiology"

PROGRAM AND ABSTRACTS

THE AMERICAN SOCIETY FOR PHOTOBIOLOGY THANKS THE FOLLOWING

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WELCOME

TO THE 2026 AMERICAN SOCIETY FOR PHOTOBIOLOGY BIENNIAL MEETING

Dear ASP members and guests,

On behalf of the organizing committee, it is my pleasure to welcome you to the 43rd American Society for Photobiology Biennial Meeting in Scottsdale, Arizona, May 16–19, 2026. This year's theme, "From Foundations to Frontiers in Photobiology," reflects our commitment to honoring the fundamental discoveries that shaped our field while advancing emerging areas that will define its future.

This meeting is especially meaningful as it is our first gathering since the passing of ASP Founder, Dr. Kendric C Smith, on November 1, 2024. His vision and leadership helped establish the foundation of our Society and shaped the field of photobiology as we know it today. We honor his legacy throughout this meeting, including through the Kendric C. Smith Symposium, which celebrates the scientific excellence and spirit of inquiry that he championed.

We are delighted to bring together a vibrant and international community of scientists, clinicians, trainees, and industry partners for a dynamic and engaging program. Across plenary and award lectures, topical symposia, contributed talks, and poster sessions, ASP 2026 showcases the full breadth of photobiology, from photomedicine and photodynamic therapy to photochemistry, photosensory biology, environmental photobiology, and emerging frontiers including AI, quantum-enabled photobiology, and advanced imaging technologies.

The meeting features an exciting array of scientific sessions alongside special events designed to foster connection and professional growth. These include mentoring lunches, career conversations, networking receptions, and trainee-focused programming, all aimed at supporting the next generation of photobiologists and strengthening our community. We are also proud to continue our tradition of special symposia, including the Kendric C. Smith Symposium, as well as international collaborations through the ASP–ESP Joint Symposium. This year's joint session, "Photosensitization: a Tribute to Professor Miguel A. Miranda," honors his profound contributions to photochemistry and photobiology and highlights ongoing advances inspired by his work.

Set against the unique landscape of the Sonoran Desert, Scottsdale provides an inspiring setting for scientific exchange, collaboration, and new ideas. We encourage you to take full advantage of both the scientific program and the many opportunities to connect with colleagues, form new collaborations, and engage with the broader ASP community.

We are thrilled to have you join us for ASP 2026 and look forward to a stimulating and memorable meeting.

With best regards,
Sherri A. McFarland
President, American Society for Photobiology

ASP 2026 MEETING ORGANIZATION

ASP gratefully acknowledges the following individuals for their outstanding contributions to the development of the scientific program.

Chairs
Sherri A. McFarland
Masaoki Kawasumi

Session Organization
Marta Erminia Alberto
Veronica Bahamondes Lorca
Douglas Brash
Theresa Busch
Carlos Crespo
Clara Curiel-Lewandrowski
Janusz Dabrowski
Andrés Durantini
Antonio Francés-Monerris
Emily Gawrys
Phoebe Glazer
Beth Gaillard
Ajith Karunarathne
Gurleen Kaur
Masaoki Kawasumi
Indermeet Kohli
Ryan McCulla
Sherri A. McFarland
Santi Nonell
Eduardo Ruvolo
David Sliney
Gal Shafirstein
Ge Shi
Wenfang Sun
Alisher Talgatov
Georg Wondrak
Shiyong Wu
Xiaojing Yang

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Tayyaba Hasan
Yu-Ying He
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John Streicher

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(ASP Conference Registrar)
Elizabeth Terry-Humen
(Membership Director)
Maryana Wood
(Meeting Assistant)
Amy Wride-Graney (Program Manager)

GENERAL INFORMATION

Registration Desk Hours

- Paloma Foyer
  Saturday, May 16: 11:00 AM – 6:30 PM
  Sunday, May 17: 8:30 AM – 3:00 PM
  Monday, May 18: 7:30 AM – 3:00 PM
  Tuesday, May 19: 7:30 AM – 3:00 PM

Exhibit Hall Hours

- Paloma Foyer
  Sunday, May 17: 9:30 AM – 4:00 PM
  Monday, May 18: 9:30 AM – 4:00 PM
  Tuesday, May 19: 9:30 AM – 3:00 PM

Meeting rooms

- Posters – Hacienda
- Opening Reception – Paloma Garden
- Mentoring Sessions – Paloma I-III
- Concurrent Sessions – Kiva, Paloma I-III, Mohave I-II
- Editors Dinner (Invitation Only) – Offsite at Roaring Fork (4800 N. Scottsdale Rd, Suite 1700, Scottsdale, AZ 85251)
- Council Meeting (ASP Officers, Councilors, and Associate Councilors only) – Encanto I-II
- President's Pizza Party (Associate Members and ASP leadership only) – Offsite at Grimaldi's Coal Brick Oven Pizzeria (4000 N. Scottsdale Rd, Suite 105, Scottsdale, AZ 85251)

Food and drink

- Kendric C. Smith Opening Reception: Saturday, May 16, from 7:30 PM – 10:00 PM, food and drink will be provided.
- Poster Session: Sunday May 17, from 5:15 PM – 7:15 PM, refreshments will be provided and a cash bar.
- Awards Banquet/Party: Monday, May 18, from 6:00 PM – 10:00 PM. Come show your support for the awardees. Food and Drink will be provided. This is a ticketed event, if you don't have a ticket stop by registration.

Coffee breaks

- Paloma Foyer
  Sunday, May 17: 11:05 AM – 11:30 AM
  Monday, May 18: 10:05 AM – 10:30 AM
  3:00 PM – 3:15 PM
  Tuesday, May 19: 10:05 AM – 10:30 AM
  3:00 PM – 3:15 PM

Poster presentation

- Hacienda I
- Posters (up to 42 x 42 inches) can be displayed throughout the meeting (4 days: 4:00 pm, Saturday, May 16 to 5:00 pm, Tuesday, May 19).
- Push pins will be provided.

Oral presentation

- Please bring your presentation on a USB drive to the session room before the session starts.

Oral presentation length

- Concurrent session presentations, Kendric C. Smith Symposia Lectures
  - Please check schedule
- "Come See My Presentation" (1 slide without animation)
  - Please check schedule

Embassy Suites by Hilton Scottsdale

- Resort breakfast – Azul's Kitchen
  - 6:00 AM – 9:30 AM, Monday-Friday
  - 7:00 AM – 10:30 AM, Saturday and Sunday
- Evening cocktail reception – Azul's Kitchen
  - 5:00 PM – 6:30 PM
- Free shuttle to Old Town Scottsdale
  - 7 days a week: 10:00 AM – 6:00 PM.

PROGRAM HIGHLIGHTS

Theme **"From Foundations to Frontiers in Photobiology"**

- Kendric C. Smith Memorial Symposium and Reception featuring 6 award lectures
  - Jean Cadet (Lifetime Achievement), Yu-Ying He (Research), Alexander Greer (Photon), Jean-Luc Ayitou (New Investigator), Clemens Burda (Light Path), Ewan Eadie (Photocite A)
- 13 plenary lectures
  - Past ASP President Keith Cengel, Bern Kohler, María Gabriela Lagorio, Luis Larrondo, Edward Maytin, Ana Moore, Daniel Morse, Past ESP President Massimo Trotta, Timothy Zhu, and Matias Zurbriggen
  - ASP Presidential Lecture (Sherri McFarland)
  - ESP Presidential Lecture (Pål Kristian Selbo)
  - Editor's Lecture (Alexander Greer)
- 143 oral presentations in 28 technical sessions spanning photomedicine, photochemistry and photophysics, photosynthesis, environmental photobiology, and emerging frontiers including AI and quantum-enabled photobiology
- 45 poster presentations and a dedicated Poster & Networking Reception
- 30 "Come See My Presentation" elevator pitches
- Special symposia including the ASP–ESP Joint Symposium in tribute to the late Prof. Miguel Ángel Miranda and his contributions to photobiology
- Business Meeting
- ASP Gala and Awards Ceremony, featuring a Southwest dinner buffet and live music
  - 7 ASP Awards
  - 24 ASP Urbach Travel Awards
  - Numerous ASP and sponsor presentation awards for trainees
- 3 mentoring lunches, with career development and networking opportunities for trainees and early-career scientists
- Election of new Associate Councilors from the Associate Membership
- Industry engagement, exhibits, and translational science programming
- Outreach program for >60 local high school and undergraduate students
- ASP traditions and signature community events, including the Camelback hike (paid event open to all), the President's Pizza Party (Associate Members and ASP leadership), Past Presidents' Luncheon (ASP Past Presidents only), and Editor's Dinner (invitation only)
- A highly interactive forum connecting academia, industry, and emerging leaders in photobiology

ASSOCIATE MEMBER ACTIVITIES

Dear Associate Members,

The Associate Council of the American Society for Photobiology (ASP) is pleased to host a series of networking and mentoring events designed specifically for students and postdoctoral fellows attending the ASP 2026 Biennial Meeting in Scottsdale, Arizona. These events provide opportunities to build professional connections, engage with peers and mentors, and support career development across academia, industry, and beyond.

All events listed below are for Associate Members.

Career Conversations and Speed Networking Lunch
Sunday, May 17th, 1:00 PM – 2:30 PM

Join us for an interactive mentoring session featuring small-group discussions and rapid networking with established scientists from both academia and industry. This session is designed to facilitate meaningful conversations about career paths, research directions, and professional development.

Invited Mentors: Dr. Ratan Chaudhari, Dr. Eduardo Ruvolo, Dr. Curtis Cole, Dr. David Sliney, Dr. Nathan Babcock, Greta Bučytė, Ana Moore, Dr. Santi Nonell

ASP President's Pizza Party; Sunday, May 17th, 7:30 PM – 9:30 PM

Enjoy a relaxed evening with fellow Associate Members and ASP leadership. This informal gathering provides a great opportunity to connect socially while enjoying complimentary pizza and refreshments.

Associate Councilor Elections; Monday, May 18th, 12:00 PM – 1:00 PM

Participate in the Associate Member election process and help shape the future leadership of ASP. Your voice matters in guiding initiatives that support trainee engagement and professional growth.

Peer Mentoring Lunch Session; Tuesday, May 19th, 12:00 PM – 2:00 PM

This peer-focused session encourages open discussion among Associate Members about shared experiences, challenges, and strategies for success, including navigating training, transitioning to independence, and exploring diverse career pathways. A panel of mentors will share key experiences in their career journey and offer valuable guidance.

Invited Mentors: Dr. Huang-Chiao (Joe) Huang, Dr. Janusz Dabrowski, Dr. Jean-Luc Ayitou, Dr. Shobhan Gaddameedhi, Dr. Masaoki Kawasumi, Dr. Tayyaba Hasan.

All of the above events are included with Associate Member registration. We strongly encourage you to participate and take full advantage of these opportunities to connect and grow within the ASP community.

We encourage you to share your experiences, photos, and impressions from these events using #ASP2026 and to connect with ASP on social media: Instagram (ASPhotobio), Bluesky (@photobiology.bsky.social), and LinkedIn (American Society for Photobiology).

We look forward to seeing you in Scottsdale.

Kind regards,
Sumiao Pang, Gurleen Kaur, Akshaya Sreedharan Iyer, Zeinab Fayyaz
Associate Councilors

OUTREACH PROGRAM

SCIENTIFIC CONFERENCE EXPERIENCE FOR LOCAL HIGH SCHOOL, UNDERGRADUATE, AND MEDICAL STUDENTS

Date & Time: Saturday, May 16, 2026 at 12:00–3:30 pm

Location: Embassy Suites by Hilton Scottsdale Resort · Mohave I

Photobiology researchers study the interactions of light with living organisms. Have you ever attended a research conference and discussed science with researchers? Join this outreach program (3.5 hours) with free registration (first 100 registrants; meals and transportation are not included).

Outreach Program Chairs:

Dr. Karen Hastings (University of Arizona College of Medicine – Phoenix)
Dr. Masaoki Kawasumi (The Ohio State University)

12:00 PM – 1:00 PM
Outreach Program (including 6 student presentations)

12:00 pm – 12:01 pm	Welcome Masaoki Kawasumi (The Ohio State University)
12:01 pm – 12:06 pm	How to Get the Most Out of Your First Research Conference Karen Hastings (University of Arizona College of Medicine – Phoenix)
12:06 pm – 12:15 pm	Predicting Cancer With Machine Learning: cSCC From Bench to Bedside Scott Penner (University of Arizona College of Medicine – Phoenix)
12:15 pm – 12:24 pm	Melanoma Risk in Airplane Pilots Sofia Prevatt (Embry-Riddle Aeronautical University Prescott)
12:24 pm – 12:33 pm	The Synergistic Antimicrobial Efficacy of Yarrow-Infused Alginate Hydrogels Mehak Vohra (Hamilton High School)
12:33 pm – 12:42 pm	First Real-World Post-Market Clinical Study of a Handheld AI Elastic Scattering Spectroscopy Device: Assessing Point-of-Care Utility at a Federally Qualified Health Center Eashan Das (University of Arizona College of Medicine – Phoenix)
12:42 pm – 12:51 pm	Structural Features Guide Candidate Selection for Increasing Immunogenicity of Neoantigens in UV-Induced Cutaneous Squamous Cell Carcinoma Mariam Zubair (Arizona State University)
12:51 pm – 1:00 pm	"Light" in Brain Medicine: Applications in Neurodegenerative Diseases and Brain Tumors Jagan Garikapaty (BASIS Scottsdale)

1:30 PM – 3:30 PM Kiva
Join the Main Program: From Foundations to Frontiers in Photobiology

- Opening Remarks (30 min)
- Plenary Lecture (30 min) "Biophotonics: How Living Systems Encode Information in Light" by Dr. María Gabriela Lagorio
- "Come See My Presentation" (30 min) [1-minute presentation with 1 slide]
- Plenary Lecture (30 min) "Artificial Photosynthetic Systems" by Dr. Ana Moore

ASP 2026 AWARDS

ASP Lifetime Achievement Award

Jean Cadet
Université de Sherbrooke

ASP Research Award

Yu-Ying He
University of Chicago

ASP New Investigator Award

Jean-Luc Ayitou
University of Illinois Chicago

ASP Photon Award

Alexander Greer
Brooklyn College of the City University of New York

ASP Light Path Award

Clemens Burda
Case Western Reserve University

ASP Editor's Student Research Award

Serah Essang
Brooklyn College of the City University of New York

Photocite-A Award

Louise Finlayson
TriTech Institute

Photocite-B Award

Maurício S. Baptista
Universidade de São Paulo

Jean Cadet
Université de Sherbrooke

Alexander Greer
Brooklyn College of the City University of New York

Andrés H. Thomas
Universidad Nacional de La Plata

ASP Urbach Travel Awards

Established in memory of Fred Urbach (ASP Past President), ASP Urbach Travel Awards are intended to assist ASP Associate Members (students and postdocs) with travel expenses in order to present a poster or talk of their work at the ASP Meetings.

Habiba Afrin
J. Alejandro Arboleda Murillo
Bulus Bako
Paul Danyi
Kalara Develigoda Gamage
Zeinab Fayyaz
Alexis Iverson
Akshaya Iyer
Gurleen Kaur
Nikita Kulkarni
Andrew Langley
Chris Lawson
Caitlyn Lewis
Dalton Lucas
Arghavan Mollazadeh
Broderick Nelson
Marta Overchuk
Henry Politte
Ronak Shethia
Ge Shi
Brayden Stackhouse
Alisher Talgatov
Aarati Upreti
Abbas Vali

PLENARY SESSION SPEAKER PROFILES Room Location: Kiva

Saturday, May 16, 2026

2:00 PM – 2:30 PM
Biophotonics: How Living Systems Encode Information in Light

María Gabriela Lagorio

María Gabriela Lagorio is a physicochemist working at the interface of photochemistry and biophotonics, with a focus on light-biological matter interactions. She is a Principal Researcher at CONICET and Professor at the University of Buenos Aires. She holds a PhD from the same institution, serves on the Editorial Board of the Journal of Photochemistry and Photobiology B: Biology, and is currently President of the Argentine Society of Environmental Science and Technology.

Her research advances the use of chlorophyll fluorescence, reflectance spectroscopy, and optical methodologies to probe photosynthesis, plant function, and environmental stress. She has developed physical models to describe light propagation in highly scattering, chromophore-rich systems, improving the interpretation of optical signals. Her work also explores fluorescence across organisms—from plants to birds and frogs—as a functional biosignal in biological communication.

3:00 PM – 3:30 PM
Artificial Photosynthetic Systems

Ana Moore

Regents' Professor Ana Moore is a member of the Arizona State University (ASU) School of Molecular Sciences. She received the undergraduate education at the University of La Plata, Argentina, the M.Sc. from the University of Rio de Janeiro, Brazil, and the Ph.D. from Texas Tech University. She did her postdoctoral work at the University of Washington before she came to ASU. Working alongside colleagues Devens Gust and Tom Moore, she led a team of students and postdoctoral associates in developing bio-inspired molecular systems for energy conversion and storage. Their work helped positioned ASU as a leader in the field of both natural and artificial photosynthesis.

Sunday, May 17, 2026

9:00 AM – 9:30 AM
Natural and Synthetic Optogenetic Circuits: mapping transcriptional responses and visualizing population dynamics through the eyes of fungi

Luis Fernando Larrondo Castro

Dr Luis F. Larrondo received his Ph.D. in Cellular and Molecular Biology at the P. Universidad Catolica de Chile (PUC), studying enzymology and genomics of lignin degradation by white rot fungi. Then, during his postdoc at Dartmouth Medical School, USA, he became interested in fungal photobiology and circadian regulation, developing different tools such as a high-throughput platform for in vivo circadian studies in fungal systems. In 2009, he joined the PUC, where he is currently a Full Professor and since 2018, the director of the Millenium Institute for Integrative Biology (iBio) and a HHMI International Research Scholar (2017-2022). His laboratory has pioneered work in fungal optogenetics, and Synthetic Biology, aiming to understand how environmental signals (i.e. light and temperature) modulate complex genetic programs associated with rhythmic changes in gene expression, and daily modulation of fungal physiology.

9:30 AM – 10:00 AM
Clinical Applications Inside the Body: the Challenges of Putting PDT Where the Sun Doesn't Ordinarily Shine

Keith Cengel

Dr Cengel is a Professor in the Department of Radiation Oncology, the Director of the Photodynamic Therapy Program, the Executive Director for Penn Mesothelioma Program and the Vice Chair of the Abramson Cancer Center's Data and Safety Monitoring Committee. He is also a past president of the American Society for Photobiology. His undergraduate studies in biology and biochemistry (BS, BS), and graduate studies in cellular and molecular biology (MS, PhD) and MD were completed at the University of Illinois at Urbana Champaign. He performed residency and postdoctoral training at the University of Pennsylvania and is a board-certified radiation oncologist with 20 years of clinical sub-specialization treating patients with thoracic diseases (malignant and non-malignant) and sarcoma. As a physician–scientist and translational researcher, his work focuses on integrating radiation dosimetry, organ system physiology, and cellular signaling in both preclinical and clinical models to better understand, predict, and modulate the therapeutic index of ionizing and non ionizing radiation therapy. With the overarching goal of accelerating the adoption of novel therapies in clinical practice, he employs both bench to bedside and bedside to bench approaches, using diverse models that range from advanced tissue mimicking cell culture systems to large and small animal clinical and preclinical studies. His research efforts have been funded by grants from the NIH, the DOD and the National Space Biomedical Research Institute. Most recently, he has led efforts at Penn to develop a translational research program for FLASH radiotherapy, collaborating with partners at Penn's School of Veterinary Medicine to develop and run clinical trials with companion animals from the PennVET oncology clinic.

2:30 PM – 3:00 PM

Optogenetic control of biological processes: from photoreceptor engineering to their implementation in microbial, animal and plant systems

Matias Zurbriggen

Prof. Dr. Matias Zurbriggen, Born in 1979, has been head of the Institute of Synthetic Biology since October 2015, a specialist in the field of molecular biology, organic chemistry, engineering, nanobiotechnology and information technology, at the HHU in Düsseldorf and is a member of the excellence cluster CEPLAS. He works with his team to develop and apply innovative synthetic biology and optogenetics techniques to understand signal processes and regulatory networks under temporal and spatial control. The research focus is on the study of light and the hormonal signaling pathways in plants, with the aim of developing so-called optical switches.

Monday, May 18, 2026

8:00 AM – 8:30 AM

ESP Presidential Lecture

Photochemical Approaches for Strengthening Cancer Immunotherapy

Pål Selbo

Pål K. Selbo is a photobiologist with an M.Sc. in biology from NTNU in Trondheim, Norway (1994) and a PhD in biochemistry from the University of Oslo (2001), where he helped establish the drug delivery method Photochemical Internalization (PCI) in the lab of Prof. Kristian Berg at the Department of Radiation Biology, Oslo University Hospital. He completed a postdoctoral fellowship with Prof. Tayyaba Hasan at the Wellman Center for Photobiology, Harvard Medical School (HMS) and Massachusetts General Hospital (2002–2003) and in the PCI lab (2003-2007). Pål is the head of the PCI group at the Department of Radiation Biology, Oslo University Hospital. His research focuses on overcoming resistance to photodynamic therapy (PDT), targeting cancer stem cells, and enhancing cancer immunotherapy using PCI and PDT-based strategies. He currently serves as President of both the European Society for Photobiology (ESP) and the Norwegian Society for Photobiology and Photomedicine (NOFFOF).

Plenary Session Speaker Profiles

8:30 AM – 9:00 AM
Repurposing Bacterial Photosynthesis

Massimo Trotta

Massimo is Research Director Consiglio Nazionale delle Ricerce in Bari, Italy and Professor specialized in catalysis and bioenergetics. From pioneering bio-hybrid energy devices to serving as President of the European Society for Photobiology, his work explores how nature's "molecular machinery" can power a greener planet. An accomplished mentor and science communicator, he is the author of *The Power of Threes* and a recipient of the National Academy of Sciences Cozzarelli Prize. Massimo serves as a Horizon Europe expert and is a Senior Editor for the Comprehensive Series in Photochemical & Photobiological Sciences.

2:00 PM – 2:30 PM
Singlet oxygen dosimetry and light fractionation on PDT efficacy

Tim Zhu

The research interests of Timothy C. Zhu focus on Photodynamic Therapy (PDT), Photobiomodulation, Radiation dosimetry, External beam, and Cherenkov imaging. These include the development of explicit and implicit dosimetry of PDT including light, photosensitizer drug uptake, and oxygen concentration; deformable image co-registrations; image-guided surgical interventions and optical 3D imaging. He has a particular interest in the inter-applications of biophotonics and ionizing radiation for dosimetry, combined treatment, outcome prediction, and functional imaging.

2:30 PM – 3:00 PM
Reflectin: a protein machine dynamically fine-tuning the color of squid skin for camouflage and communication

Daniel Morse

Daniel Morse is Distinguished Professor Emeritus of Molecular Biology and Biomolecular Science and Engineering at the University of California, Santa Barbara (UCSB), and Founding Director Emeritus of the UCSB-Caltech-MIT Institute for Collaborative Biotechnologies. His research is focused at the interface between biophotonics, protein engineering, materials science and optoelectronics. He received his B.A. in Biochemistry from Harvard, his Ph.D. in Molecular Biology from Einstein College of Medicine, conducted postdoctoral research in Molecular Genetics at Stanford and was Professor of Microbiology and Molecular Genetics at Harvard Medical before coming to Santa Barbara. Developer of "Silicon Biotechnology," he was honored by Scientific American as one of the top 50 technology leaders of the year and elected Fellow of the Materials Research Society, AAAS and the Smithsonian Institution.

Tuesday, May 19, 2026

8:00 AM – 8:30 AM
The Tortoise and the Hare in Photodynamic therapy: How to deliver painless PDT

Edward Maytin

Edward V. Maytin, MD PhD is an Associate Professor of Molecular Medicine at Cleveland Clinic Lerner College of Medicine (Case Western Reserve School of Medicine), and an investigational dermatologist at the Cleveland Clinic. For over 20 years, he has seen patients and directed translational research projects, including basic science initiatives and clinical trials of photodynamic therapy (PDT) for skin cancer. Many of these scientific endeavors were conducted as part of an NIH-funded Program Project in collaboration with Dr. Tayyaba Hasan (Massachusetts General, Boston) and Dr. Brian Pogue (Thayer School of Engineering, Dartmouth College). Other studies have been investigator-initiated clinical trials performed in collaboration with pharmaceutical sponsors. All have been connected by a common goal of understanding and optimizing the delivery of PDT for patients with skin cancer and precancer.

8:30 AM – 9:00 AM
Ultrafast photophysics in DNA and eumelanin

Bern Kohler

Bern Kohler is Professor and Ohio Eminent Scholar in the Department of Chemistry and Biochemistry at The Ohio State University. His research team pioneered the use of femtosecond laser spectroscopy to study the photophysical and photochemical decay pathways of excited states in DNA, reporting in 2000 that the hydrated nucleobases have lifetimes shorter than 1 picosecond due to nonadiabatic dynamics governed by conical intersections. More recently, his team studies how nanoscale structuring shapes the photoproperties of nature's ubiquitous melanin pigments and uses ultrafast spectroscopy to uncover photocatalytic mechanisms in metal oxide nanoparticles. Prof. Kohler received a B.S. degree in chemistry from Stanford University (1985), a Ph.D. in physical chemistry from MIT (1990), and completed postdoctoral research at the Swiss Federal Institute of Technology in Zurich, Switzerland and at the University of California, San Diego. Prof. Kohler is a fellow of the AAAS and the winner of the 2017 Inter-American Photochemical Society Award in Photochemistry. He is the past co-Chair of the Gordon Research Conferences on Photochemistry and on Electronic Spectroscopy and Dynamics. Prof. Kohler is also a past President of the Telluride Science Research Center (TSRC), and he currently serves as the Program Chair and Chair-Elect of the Physical Division of the American Chemical Society. He has served for more than 20 years as an Associate Editor for the journal *Photochemistry and Photobiology*.

Plenary Session Speaker Profiles

2:00 PM – 2:30 PM

ASP Presidential Lecture

From Foundations to Frontiers in Photobiology: Molecules to Medicine with Photoactive Metal Complexes

Sherri McFarland

Sherri is a professor in the Department of Chemistry and Biochemistry at the University of Texas at Arlington (UTA) and is the current President of the American Society for Photobiology (ASP). Her research areas include synthetic and natural products chemistry, medicinal inorganic chemistry, photophysics and photochemistry, and photomedicine. She has a passion for translational research and entrepreneurship. Her research group developed and licensed a ruthenium coordination complex that has advanced to clinical trials for treating bladder cancer patients with photodynamic therapy. Sherri also co-founded a company that has commercialized a natural product extract as a photoantimicrobial for improving oral health.

2:30 PM – 3:00 PM

Editor's Lecture

Photochemistry and Photobiology Editor's Lecture

Alexander Greer

Alexander Greer is a professor of chemistry at Brooklyn College of the City University of New York (CUNY). His research focuses on mechanistic details in photochemical and biological processes, including those in PDT. He served as ASP President from 2020-2022 and helped to launch initiatives such as LatASP and the monthly webinar series. He co-founded SingletO2 Therapeutics LLC, and currently serves as an Editor-in-Chief of *Photochemistry and Photobiology*, director of the Brooklyn College Cancer Center, and co-chair of the Committee of Concerned Scientists.

EXHIBITOR LISTING

Algorithmiq

algorithmiq.fi

We develop quantum algorithms that seamlessly integrate the best classical computers with the most advanced quantum computers. Our cutting-edge quantum solutions are designed to push the boundaries of scientific discovery at an atomistic-scale resolution. With these innovations, we aim to solve life science problems that are currently deemed impossible.

BWtek Medical

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949-291-3493
www.bwtekmed.com

BWtek Medical designs and manufactures photonic-based medical devices for therapy and diagnosis under GMP/ISO13485/FDA standards. Since 1997, we've collaborated with top institutions to develop laser therapies, 3D bio-printers, and optical spectroscopic instruments. We support academic and start-up partners with engineering, clinical trials, FDA compliance, and commercialization.

La Roche-Posay

www.loreal.com/en/dermatological-beauty-division/la-roche-posay/

La Roche-Posay is a French skincare brand owned by the L'Oréal Group and sits within its Dermatological Beauty division. It is renowned for collaborating with dermatologists to develop safe, effective products primarily for sensitive skin. Key product lines include Anthelios sunscreens, Effaclar acne treatments, and Lipikar body care.

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PhotoDynamic, Inc

https://www.photo-dynamic.com/
info@photo-dynamic.com

PhotoDynamic is building a leading edge antimicrobial platform, with the impact of treatment and the power of prevention, balancing safety and efficacy.

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CONFERENCE CODE OF CONDUCT

The American Society for Photobiology (ASP) is dedicated to ensuring a discrimination-free and harassment-free environment at its conferences. All attendees (including, but not limited to, participation as a volunteer, vendor, exhibitor, registrant, member of the public, or guest) are required to adhere to the ASP Conference Code of Conduct to maintain an inclusive, safe, and respectful atmosphere.

Expected Behavior

- Respect and Dignity: Treat all individuals with respect and dignity, valuing diversity and differing viewpoints.
- Non-Discrimination: Refrain from discrimination based on race, ethnicity, gender, sexual orientation, disability, age, nationality, or religion.
- Harassment-Free Environment: Avoid any form of harassment, including unwelcome sexual advances, requests for sexual favors, or other verbal or physical harassment of a sexual nature.
- Professional Behavior: Engage in professional behavior, avoiding disruptive conduct during oral and poster presentations.
- Confidentiality and Privacy: Respect the confidentiality and privacy of other participants, and do not disclose personal or sensitive information without consent.

Reporting Procedures

If you experience or observe harassment or other unacceptable behavior, we recommend that you write down the details as soon as possible, in as much detail as possible, to help you to recall specific events in the future. If you believe you have experienced or observed harassment, notify ASP in one or more of the following ways:

- The Code of Conduct rapid response line (703) 592-9946.
- Via our confidential reporting web portal burkinc.ethicspoint.com which connects to ASP's independent Safety Officer.
- At the meeting registration desk for in-person meetings.
- By contacting one of the Society's Executive Officers (President, Past President, President-Elect, Secretary, Treasurer) or ASP 2026 Program Chair.

Enforcement

The ASP will not tolerate harassment of conference participants in any form or retaliation for reporting of misconduct.

- Immediate Compliance: Attendees asked to stop any inappropriate behavior are expected to comply immediately.
- Consequences of Misconduct: The ASP reserves all rights to take any lawful and appropriate remedial and/or preventative action with respect to any individual who does not abide by this Code of Conduct and/or the incorporated policies, or disregards or violates sanctions imposed by other adjudicating bodies (e.g., court orders, universities), including:
  - Removal from or denial of access to the meeting without a refund of any applicable registration fees.
  - Disqualification from attendance at future meetings.
  - Reporting to the attendee's institution or employer if necessary.

Commitment to Inclusivity

- ASP is committed to fostering an inclusive environment where all participants feel welcome and valued, regardless of their background, identity, or experience.
- By fostering an inclusive and respectful environment, ASP aims to ensure a productive and enjoyable experience for all participants.

ASP President
Sherri McFarland

ASP 2026 Program Chairs
Sherri McFarland
Masaoki Kawasumi

ABBREVIATED SCHEDULE

Saturday, May 16

TIME	EVENT	CHAIR(s)	ROOM
12:00 PM – 1:30 PM	Outreach Program	Karen Hastings, Masaoki Kawasumi	Mohave I
1:30 PM – 2:00 PM	Opening Plenary Session: From Foundations to Frontiers in Photobiology – Opening Remarks	Sherri McFarland	Kiva
2:00 PM – 2:30 PM	Plenary Lecture – Biophotonics: How living systems encode information in light. Maria Gabriela Iagorio		Kiva
2:30 PM – 3:00 PM	Come See My Presentation		Kiva
3:00 PM – 3:30 PM	Plenary Lecture – Artificial Photosynthetic Systems. Ana Moore		Kiva
4:00 PM – 7:30 PM	Kendric C. Smith Symposium		Kiva
7:30 PM – 10:00 PM	Reception		Paloma Garden

Sunday, May 17

TIME	EVENT	CHAIR(s)	ROOM
6:00 AM – 8:00 AM	Camelback Hike (pre-registration required		Offsite
9:00 AM – 9:30 AM	Plenary Lecture – Natural and Synthetic Optogenetic Circuits: mapping transcriptional responses and visualizing population dynamics through the eyes of fungi. Luis Fernando Larrondo Castro		Kiva
9:30 AM – 10:00 AM	Plenary Lecture – Clinical Applications Inside the Body: the Challenges of Putting PDT Where the Sun Doesn't Ordinarily Shine. Keith Cengel		Kiva
10:05 AM – 11:05 AM	Chemiexcitation in Mammalian Biology and Medicine	Doug Brash	Mohave II
10:05 AM – 1:00 PM	Dermato-Oncology: UV-Induced Skin Carcinogenesis Part 1	Masaoki Kawasumi	Paloma I-III
10:05 AM – 1:00 PM	Molecules for Phototherapy and Bioimaging Part 1	Wenfang Sun	Mohave I
10:05 AM – 1:00 PM	Translational Photodynamic Strategies: Immune Responses, Priming, and Therapeutic Synergy	Huang Chiao (Joe) Huang	Kiva
11:30 AM – 1:00 PM	Ocular Photobiology and Visual Processing	Beth Gaillard	Mohave II
1:00 PM – 2:30 PM	Career Conversations & Speed Networking Lunch Mentoring Session (Associate Members only)		Paloma I-III
1:00 PM – 2:30 PM	Past Presidents' Lunch (Invitation Only)		Encanto I-II
2:30 PM – 3:00 PM	Plenary Lecture – Optogenetic control of biological processes: from photoreceptor engineering to their implementation in microbial, animal and plant systems. Matias Zurbriggen		Kiva
3:15 PM – 5:15 PM	The Skin Cancer Epidemic: An Arizona Perspective on Innovative Scientific and Population Based Approaches to Address the Challenge	Georg Wondrak	Paloma I-III
3:15 PM – 5:15 PM	Photopharmacology	Phoebe Glazer	Mohave I
3:15 PM – 5:15 PM	UVC Germicidal Science	David Sliney	Mohave II
3:15 PM – 5:15 PM	Antimicrobial Photodynamic Therapy Part 1	Janusz Dabrowski	Kiva
5:15 PM – 7:15 PM	Poster and Networking Reception		Hacienda I
7:30 PM – 9:30 PM	ASP Editor's Dinner (Invitation only)		Off site
7:30 PM – 9:30 PM	President's Pizza Party (Associate Members and ASP leadership)		Off site

ABBREVIATED SCHEDULE

Monday, May 18

TIME	EVENT	CHAIR(s)	ROOM
8:00 AM – 8:30 AM	ESP Presidential Lecture – Photochemical Approaches for Strengthening Cancer Immunotherapy. Pål Selbo		Kiva
8:30 AM – 9:00 AM	Plenary Lecture – Repurposing Bacterial Photosynthesis. Massimo Trotta		Kiva
9:05 AM – 12:00 PM	From Lab to Launch: Entrepreneurship in Photobiology Spotlight	Shiyong Wu, Sumiao Pang	Paloma I-III
9:05 AM – 12:00 PM	ESP-ASP Joint Session: Photosensitization: a Tribute to Professor Miguel A. Miranda	Santi Nonell, Sherri McFarland	Mohave I
9:05 AM – 12:00 PM	Photobiology Across the Visible Spectrum: Oxidative Stress, Skin Pigmentation, Clinical Responses, Photoprotection, Aging, and Photocarcinogenesis	Eduardo Ruvolo, Indermeet Kohli	Mohave II
9:05 AM – 12:00 PM	Structures and Mechanisms of Photoreceptors and Light-sensitive Proteins	Xiaojing Yang	Kiva
12:00 PM – 12:45 PM	ASP Executive Council Meeting (ASP Officers only)		Encanto I-II
12:00 PM – 1:00 PM	Associate Councilors Election (Associate Members only)		Paloma I-III
1:00 PM – 1:45 PM	ASP Business Meeting (open to all)		Kiva
2:00 PM – 2:30 PM	Plenary Lecture – Singlet oxygen dosimetry and light fractionation on PDT efficacy. Tim Zhu		Kiva
2:30 PM – 3:00 PM	Plenary Lecture – Reflectin: a protein machine dynamically fine-tuning the color of squid skin for camouflage and communication. Daniel Morse		Kiva
3:15 PM – 5:15 PM	Advancing Light Therapy in the Clinical Setting	Gal Shafirstein	Paloma I-III
3:15 PM – 5:15 PM	Computational Photobiology / Quantum Computing in Photobiology	Marta Alberto, Antonio Francés-Monerris	Mohave I
3:15 PM – 5:15 PM	UVB-Induced DNA Damage, Repair, and Skin Carcinogenesis	Veronica Bahamondes Lorca	Mohave II
3:15 PM – 5:15 PM	Frontiers in Photobiology Part 1: Light-Matter Interactions Across Scales	Elizabeth Gaillard	Kiva
5:15 PM – 5:30 PM	ASP Group Photo		TBD
6:00 PM – 10:00 PM	Banquet & Awards Ceremony (ticketed event)		Paloma Garden

ABBREVIATED SCHEDULE

Tuesday, May 19

TIME	EVENT	CHAIR(s)	ROOM
8:00 AM – 8:30 AM	Plenary Lecture – The Tortoise and the Hare in Photodynamic therapy: How to deliver painless PDT. Edward Maytin		Kiva
8:30 AM – 9:00 AM	Plenary Lecture – Ultrafast photophysics in DNA and eumelanin. Bern Kohler		Kiva
9:05 AM – 10:05 AM	Photothermal Therapy (PTT)	Emily Gawrys	Paloma I-III
9:05 AM – 10:05 AM	Photosensitization Mechanisms and Photoreaction Pathways	Ryan McCulla	Mohave I
9:05 AM – 12:00 PM	Ultrafast Dynamics in Photobiology	Carlos Crespo	Mohave II
9:05 AM – 10:05 AM	Frontiers in Photobiology Part 2: Light-Directed Chemical Control in Biology	Shobhan Gaddameedhi	Kiva
10:30 AM – 11:30 AM	Optogenetics	Ajith Karunarathne	Mohave I
10:30 AM – 12:00 PM	Molecules for Phototherapy and Bioimaging Part 2	Wenfang Sun	Paloma I-III
10:30 AM – 12:00 PM	Trainee Platform I	Ge Shi, Alisher Talgatov	Kiva
12:00 PM – 2:00 PM	Peer Mentoring Lunch Session (Associate Members only)		Paloma I-III
2:00 PM – 2:30 PM	ASP Presidential Lecture – From Foundations to Frontiers in Photobiology: Molecules to Medicine with Photoactive Metal Complexes. Sherri McFarland		Kiva
2:30 PM – 3:00 PM	Editor's Lecture – Photochemistry and Photobiology. Alexander Greer		Kiva
3:15 PM – 5:15 PM	Photodynamic Therapy in Translation: Innovations in Technologies through Techniques	Theresa Busch	Paloma I-III
3:15 PM – 5:15 PM	Antimicrobial PDT Part 2	Andres Durantini	Mohave I
3:15 PM – 5:15 PM	Dermato-Oncology: UV-Induced Skin Carcinogenesis Part 2	Masaoki Kawasumi	Mohave II
3:15 PM – 5:15 PM	Trainee Platform II	Gurleen Kaur	Kiva
5:15 PM – 5:45 PM	Closing remarks	Sherri McFarland, Ryan McCulla	Kiva
6:00 PM – 9:00 PM	ASP Council Meeting (ASP Officers, Councilors, and Associate Councilors only)		Encanto I-II

TECHNICAL PROGRAM

Saturday, May 16, 2026

12:00 PM – 1:30 PM Mohave I

Outreach Program

Chairs: Karen Hastings, Masaoki Kawasumi

1:30 PM – 3:30 PM Kiva

Opening Plenary Session: From Foundations to Frontiers in Photobiology

Chair: Sherri McFarland

1:30 PM – 1:45 PM
ASP 2026 Opening Remarks

PL1 2:00 PM – 2:30 PM
Plenary Lecture – Biophotonics: How Living Systems Encode Information in Light
María Gabriela Lagorio

2:30 PM – 3:00 PM
Come See My Presentation

PL2 3:00 PM – 3:30 PM
Plenary Lecture – Artificial Photosynthetic Systems
Ana Moore

4:00 PM – 7:30 PM Kiva

Kendric C. Smith Symposium

4:00 PM – 4:10 PM
Opening Remarks

A1 4:10 PM – 5:00 PM
Lifetime Achievement Award – DNA photochemistry: from model compounds to living systems
Jean Cadet

A2 5:00 PM – 5:25 PM
New Investigator Award – Engineering Smart Light-active Sulfur-based Bioactive Platforms and Hybrid Nanomaterials to Pioneer Synergistic Photobiomedical Applications & Public Health Improvement
Jean-Luc Ayitou

5:25 PM – 5:50 PM
Coffee Break

A3 5:50 PM – 6:15 PM
Research Award – Molecular mechanisms of UV damage response and skin cancer development
Yu-Ying He

A4 6:15 PM – 6:40 PM
Light Path Award – Enhancing Photodynamic Therapy With Cancer-Targeted Nanoparticles
Clemens Burda

A5 6:40 PM – 7:05 PM
Photon Award – A photochemist's perspective: From fundamental to translational science to help in photodynamic, antimicrobial, and wound care challenges
Alexander Greer

A6 7:05 PM – 7:30 PM
Photocite A Award – Monte Carlo Radiative Transfer: A Two-Decade Astrophysical-Clinical Partnership in Photomedicine
Ewan Eadie

7:30 PM – 10:00 PM Paloma Garden
Reception

9:00 AM – 10:00 AM Kiva
Plenary Lectures

PL3 9:00 AM – 9:30 AM
Natural and Synthetic Optogenetic Circuits: mapping transcriptional responses and visualizing population dynamics through the eyes of fungi
Luis Fernando Larrondo Castro

PL4 9:30 AM – 10:00 AM
Clinical Applications Inside the Body: the Challenges of Putting PDT Where the Sun Doesn't Ordinarily Shine
Keith Cengel

10:05 AM – 1:00 PM Paloma I-III
Dermato-Oncology: UV-Induced Skin Carcinogenesis Part 1
Chair: Masaoki Kawasumi

1-1 10:05 AM – 10:35 AM
Glutamatergic signaling in acral/mucosal melanoma
Suzie Chen

1-2 10:35 AM – 11:05 AM
Immunoediting restricts clonal neoantigens in human cutaneous squamous cell carcinoma
Karen Hastings

11:05 AM – 11:30 AM
Coffee break

1-3 11:30 AM – 11:52 AM
Epigenetic regulation of UV-induced photoaging: shared molecular pathways in skin carcinogenesis
Dong Hun Lee

1-4 11:52 AM – 12:14 PM
Identifying novel biomarkers for effective prevention of skin carcinogenesis
Katie Dixon

1-5 12:14 PM – 12:36 PM
Polo-like kinase 4 as a driver of cutaneous melanoma progression
Nihal Ahmad

1-6 12:36 PM – 12:58 PM
Transcriptional profiling of cutaneous squamous cell carcinoma reveals subtype-specific regulatory programs and therapeutic vulnerabilities
Masaoki Kawasumi

10:05 AM – 1:00 PM Mohave I

Molecules for Phototherapy and Bioimaging Part 1

Chair: Wenfang Sun

2-1 10:05 AM – 10:25 AM
Novel heteroleptic iridium(III) complexes containing COUBPY ligands for effective photoinduction of ferroptosis for cancer therapy
Jose Ruiz

2-2 10:25 AM – 10:45 AM
Ir(III) and Ru(II) photosensitizers for phototherapy and antimicrobial photodynamic therapy
Wenfang Sun

2-3 10:45 AM – 11:05 AM
π-Extended Ru-COUBPY complexes as potent photosensitizers for in vivo anticancer phototherapy using one-photon NIR light
Vicente Marchán

11:05 AM – 11:30 AM
Coffee break

2-4 11:30 AM – 11:55 AM
Heteroleptic Iridium Complexes show unmatched potency as antimicrobial photosensitizers for hard-to-treat bacterial and fungal infections
Gang Zheng

2-5 11:55 AM – 12:20 PM
Application of Biocompatible Organic Prodrugs in Phototherapy, Bioimaging, and Cancer Cell Proliferation Inhibition
Carlos Crespo

2-6 12:20 PM – 12:40 PM
BODIPY dyes as photosensitizers for photodynamic therapy
Shawn Swavey

2-7 12:40 PM – 1:00 PM
Protic ruthenium anticancer compounds: Describing the role of ligand charge in both photodissociation and singlet oxygen production
Elizabeth Papish

10:05 AM – 11:05 AM Mohave II

Chemiexcitation in Mammalian Biology and Medicine

Chair: Doug Brash

3-1 10:05 AM – 10:20 AM
Chemical excitation of electrons beyond skin & melanin: retina, hormones, neurotransmitters
Douglas Brash

3-2 10:25 AM – 10:40 AM
Melanin as a redox hub: from light absorption to dark-phase photochemistry
Sanjay Premi

3-3 10:45 AM – 11:00 AM
Monitoring the triplet excited states of synthetic and natural melanins by application of diene probes with different electric charge
Tadeusz Sarna

11:30 AM – 1:00 PM Mohave II
Ocular Photobiology and Visual Processing
Chair: Beth Gaillard

4-1 11:30 AM – 11:45 AM
Melatonin chemiexcitation: implications for mechanisms in the progression of macular degeneration
Elizabeth Gaillard

4-2 11:45 AM – 12:00 PM
Photosensitized Formation of Singlet Oxygen Photoreceptor Outer Segments (POS) Discs after Photobleaching of Rhodopsin
Malgorzata Rozanowska

4-3 12:00 PM – 12:15 PM
A 3D-printed bubble perfusion platform for time-resolved calcium imaging in ex vivo brain slices
Richard Ortiz

4-4 12:15 PM – 12:30 PM
Circadian rhythms of the retina and the skin
David Baeza

4-5 12:30 PM – 12:45 PM
The CIE spectral luminous efficiency function V(λ) Is not a photobiological action spectrum
David Sliney

10:05 AM – 1:00 PM Kiva
Translational Photodynamic Strategies: Immune Responses, Priming, and Therapeutic Synergy
Chair: Huang Chiao (Joe) Huang

5-1 10:05 AM – 10:35 AM
Image-guided photoimmunotherapy reveals immune priming and tumor–immune dynamics in preclinical models
Bryan Spring

5-2 10:35 AM – 11:05 AM
Photochemical Targeting of the Ovarian Cancer Lipidome: Docosahexaenoic Acid Sensitizes Ovarian Cancer Cells to Photodynamic Priming and Ferroptosis
Marta Overchuk

11:05 AM – 11:30 AM
Coffee break

5-3 11:30 AM – 12:00 PM
Beyond Cytotoxicity: Photodynamic Priming to Disable Drug Efflux and Restore Therapeutic Response
Huang Chiao (Joe) Huang

5-4 12:00 PM – 12:30 PM
Combination of vitamin D with photodynamic therapy for treatment of B16 malignant melanoma in mice
Sanjay Anand

5-5 12:30 PM – 1:00 PM
Lapatinib enhances 5-aminolevulinic acid by inhibiting both ABCG2 and EGFR signaling
Bin Chen

1:00 PM – 2:30 PM Paloma I-III
Career Conversations & Speed Networking Lunch Mentoring Session
(Associate Members only)

1:00 PM – 2:30 PM Encanto I-II
Past Presidents' Lunch (Invitation only)

2:30 PM – 3:00 PM Kiva
Plenary Session

PL5 2:30 PM – 3:00 PM
Optogenetic control of biological processes: from photoreceptor engineering to their implementation in microbial, animal and plant systems
Matias Zurbriggen

3:15 PM – 5:15 PM Paloma I-III
The Skin Cancer Epidemic: An Arizona Perspective on Innovative Scientific and Population Based Approaches to Address the Challenge
Chair: Georg Wondrak

6-1 3:15 PM – 3:25 PM
Introductory Remarks
Georg Wondrak

6-2 3:25 PM – 3:50 PM
Machine Learning Prediction of CDKN2A Germline Status in Melanoma
Collin Costello

6-3 3:50 PM – 4:15 PM
Structural changes from wild-type define tumor-rejecting neoantigens
Karen Hastings

6-4 4:15 PM – 4:40 PM
Investigating Novel Targets for Topical Immunoprevention of Keratinocytic Skin Cancer in Arizona Through the Cancer Immunoprevention Network (CIP-Net)
Sally Dickinson

6-5 4:40 PM – 5:00 PM
Developing triatomic small molecules targeting solar UV-driven skin cancers
Georg Wondrak

6-6 5:00 PM – 5:15 PM
Skin cancer in Arizona – an epidemiological perspective
Robin Harris

3:15 PM – 5:15 PM Mohave I
Photopharmacology

Chair: Phoebe Glazer

7-1 3:15 PM – 3:35 PM
Light-activated MDM2 inhibitors: Toward spatiotemporal control in cancer therapy
Sina Katharina Goetzfried

7-2 3:36 PM – 4:01 PM
Ruthenium-based photoactivated chemotherapy for the treatment of cancer: recent developments
Sylvestre Bonnet

7-3 4:02 PM – 4:27 PM
Photoactivatable Platinum(IV) Complexes: Versatile Chemical Tools for Biomedical Applications
Yaorong Zheng

7-4 4:28 PM – 4:48 PM
Ruthenium photocaged CHIR99021 for robust stem cell differentiation
Teresa Rapp

7-5 4:49 PM – 5:14 PM
Selective targeting of proteins and pathways using photopharmacology
Phoebe Glazer

3:15 PM – 5:15 PM Mohave II
UVC Germicidal Science

Chair: David Sliney

8-1 3:15 PM – 3:18 PM
Introduction to the Session: What is "Far-UV-C"?
David Sliney

8-2 3:18 PM – 3:41 PM
Longer-Wavelength Emissions from LP-Hg Lamps Influence Depth- and Lesion-Specific DNA Damage in Mouse Skin
Natalia Gutierrez-Bayona

8-3 3:41 PM – 4:04 PM
Effects of chronic 222 nm or 254 nm radiation exposure on SKH-1 mice
David Welch

8-4 4:04 PM – 4:27 PM
Photodamage in Models of Human Corneas Exposed to UVC light
Manuela Buonanno

8-5 4:27 PM – 4:50 PM
Consequences of exposure to far-UVC radiation on the eye's tear film
David Sliney

8-6 4:50 PM – 5:13 PM
Assessing skin and eye safety for far-UVC disinfection: insights from the Blueprint for Far-UVC
Brian Renda

3:15 PM – 5:15 PM Kiva
Antimicrobial Photodynamic Therapy Part 1
Chair: Janusz Dabrowski

9-1 3:15 PM – 3:35 PM
Structure–activity relationships in porphyrinoids for antimicrobial and anticancer photodynamic therapy
Janusz Dabrowski

9-2 3:35 PM – 3:55 PM
Linking ligand architecture to antimicrobial efficacy in Ru(II)-based photosensitizers for Photodynamic Therapy
Maria Auset

9-3 3:55 PM – 4:15 PM
Antimicrobial Photodynamic Inactivation with 2,3-Distyrylindoles
Alexander Kornienko

9-4 4:15 PM – 4:35 PM
Exploring antimicrobial photodynamic therapy as a treatment option for complicated urinary tract infection
Chelsie Armbruster

9-5 4:35 PM – 4:55 PM
Comparative Photophysical and Photodynamic Inactivation of Aspergillus niger Spores and Staphylococcus aureus by Rutin- and Quercetin-Loaded Nanoemulsions
Cristian Villa

9-6 4:55 PM – 5:15 PM
Harmonize, Align, Educate: the approach of PanEuCOPT COST Action (CA24127) to promote and consolidate photodynamic inactivation of microorganisms within the One Health framework
Francesca Giuntini

5:15 PM – 7:15 PM Hacienda I
Poster and Networking Reception

Photophysics and spectroscopy

P-1 Synthesis and Photophysical Studies of Pyrrolopyrrole Cyanine Boron Difluoride Derivatives for Tunable Near-Infrared Absorption and Emission for Biomedical Applications
Bulus Bako

P-2 Photophysical Studies on the Temperature-Dependent Solvatochromism of Reichardt's Dye Betaine 30
Henrik Burda

P-3 Solvent-controlled relaxation pathways of 1-cyclohexyluracil: twisted intermediates in protic media and $^1n\pi^*$ pathways in aprotic solvents
Tazrin Islam Tonny

P-4 Optically detected magnetic resonance in fluorescent proteins
Michael I. Kriel

Mechanistic photochemistry and reactive intermediates

P-5 Photochemistry and Mechanistic Studies of Diaryl Sulfondiimine Derivatives
Paul Danyi

P-6 Photochemistry and frozen matrix studies of substituted N-phenyl dibenzothiophene sulfoximines
Alexis Iverson

P-7 Extended photolysis for molecule downsizing: A biomimetic polyprenyl chain-shortening in phenolic precursors to plant defense molecules
Akshaya Iyer

P-8 Synthesis and Photochemical Evaluation of Benzonaphthothiophene N-Phenyl Sulfoximines for Controlled Release of Atomic Oxygen and Nitrene Species
Henry Politte

P-9 Chemiexcitation of melatonin promotes lutein degradation in retinal environments
Arghavan Mollazadeh

UV-induced DNA damage and cellular responses

P-10 Cholesterol-Dependent Regulation of PHB-1 Nuclear Function and Self-Aggregation Following Solar UV Irradiation in Keratinocytes
Zeinab Fayyaz

P-11 DNA Photoproduct Formation at Threshold Doses for Acute Skin Reactions Across the 200-270 nm UVC Spectrum in SKH-1 Mouse Skin
Natalia E. Gutierrez-Bayona

P-12 Mechanistic Insights into Enhanced Thymine Dimer Formation under Pulsed UVC Irradiation
Souta Kawasaki

P-13 ERLIN Proteins and Keratinocyte Survival Following Solar UV
Caitlyn Lewis

P-14 Leveraging UV damage fingerprints to discover transcription factor binding sites
Scott Stevison

P-15 Dermal application of perfluorooctanoic acid (PFOA) in SKH-1 hairless mice heightens UVB-induced DNA damage and hepatotoxicity
Naveena Sivakumar

Environmental and organismal photobiology

P-16 Patterns in Polyphylla: shifts in coloration and pattern in response to climate change
Colton Roberts-Zaffiro

P-17 Non-chemical growth control of plants using far-UV (222 nm)
Kars-Michiel H. Lenssen

Photosynthetic systems

P-18 Biocompatibility of Non-Aqueous Solvents with Rhodobacter sphaeroides Chromatophores
Claudia Zonno

P-19 Multi-scale mechanisms of light adaptation in green sulfur bacterium Chlorobaculum tepidum
Kira DeVore

Molecules for phototherapy and bioimaging

P-20 Expanding the NIR fluorophore toolbox: A general route to access polymethine-modified Cyanine 9 dyes for deep-tissue imaging
Jared C. Head

P-21 Molecular Design Strategy for Iridium(III)-based Photosensitizers to Enhance the Phototoxicity Index and Efficacy of Photodynamic Therapy
Gwangsu Yoon

P-22 Synthesis and characterization of Ir(III) and Ru(II) bis-terpyridine complexes bearing oligothienyl and pyrene-1-yl substituents
Habiba Afrin

P-23 Synthesis and characterization of homoleptic oligothienyl-substituted Ir(III) and Ru(II) bis(terpyridine) complexes: photophysics and photodynamic therapeutic effects
Kalara G. Gamage

P-24 Design and Evaluation of Photoactive Metallodrugs for Cancer Therapy
Broderick Nelson

P-25 Synthesis and Characterization of Light-Triggered Metal Complexes for Cancer Treatment
Dalton Lucas

P-26 Photobiological Applications of Light-Activated Metallodrugs
Alisher Talgatov

P-27 Tailoring Visible-Light Activated Rhodium(III)-BODIPY Complex for Oxygen-Free Photodynamic Therapy
Katherine Leslee A. Cimatu

Experimental photodynamic therapy

P-28 Molecular and biological mechanism studies of protein photooxidation to control cell fate and their therapeutic applications
Mingyu Park

P-29 Optimizing the phototherapy effects of metallodrug photosensitizers for cancer treatment
Ge Shi

P-30 Photodynamic Treatment of Glioblastoma plus Endothelial Cells Spheroid Models: Increased Proliferative and Migratory Aggressiveness of Surviving Tumor Cells due to iNOS/NO Upregulation
Witold Korytowski

P-31 Alloxazine derivatives as multifunctional agents for photodynamic therapy, cancer cell imaging, and cell proliferation inhibition
Rubej R. Khan

P-32 Preliminary results on PDT as an alternative treatment for Alzheimer's disease using organic dyes to inhibit the tau protein aggregation
Dereck Ramos

P-33 Comparative evaluation of perfluorocarbon core dependent nanodroplets for enhanced photodynamic therapy in 3D head and neck cancer spheroids
Ronak Tarun Shethia

P-34 Blue light aminolevulinic acid photodynamic therapy does not induce DNA damage in human dermal fibroblasts
Julia Stolyar

Photo-antimicrobial technologies

P-35 Superhydrophobic Burn Wound Dressing: Effect of Irradiance, Fluence, and Photosensitizer Loading on Escherichia Coli Inactivation by Airborne Singlet Oxygen
Chathuna Bodahandi

P-36 Light-Activated Natural Products as Deployable Antimicrobials
Brayden Stackhouse

P-37 Harnessing Nature and Light: Identifying Photoactive Compounds for Next-Generation Acne Treatments
Kim Luu

P-38 Investigating structure-activity relationships of photoactive metallodrugs as antimicrobials
Gurleen Kaur

P-39 Structure and Mobility of Photosensitizers in Alginate Films for Photoactive Packaging Applications
J. Alejandro Arboleda-Murillo

P-40 Photosensitizer Nanocrystals as Advanced Platforms for Antimicrobial Photodynamic Therapy
Daniel Heredia

P-41 Programmable Photo-Active CPC-like Surfactants as Environmentally Benign Alternatives to Cationic Antimicrobial Agents
Balaka Ghosh

Clinical and translational photomedicine

P-42 Non-invasive mapping of tumor fibrosis and hemodynamics with hyperspectral photoacoustic imaging
Andrew Langley

P-43 Light Transmission as an Indication for Response to Interstitial Photodynamic Therapy
Chris Lawson

P-44 Combined Photodynamic Therapy and Laser Treatment for Capillary Malformations: A Prospective Clinical Study
Rasul Sadykov

Clinical photodermatology and photosensitivity disorders

P-45 Photodermatoses: the role of light in diagnosis
Ewan Eadie

7:30 PM – 9:30 PM Offsite
ASP Editor's Dinner (Invitation only)

7:30 PM – 9:30 PM Offsite
President's Pizza Party (Associate Members and ASP leadership)

8:00 AM – 9:00 AM Kiva
Plenary Lectures

PL6 8:00 AM – 8:30 AM
ESP Presidential Lecture – Photochemical Approaches for Strengthening Cancer Immunotherapy
Pål Selbo

PL7 8:30 AM – 9:00 AM
Repurposing Bacterial Photosynthesis
Massimo Trotta

9:05 AM – 12:00 PM Paloma I-III
From Lab to Launch: Entrepreneurship in Photobiology Spotlight
Chairs: Shiyong Wu, Sumiao Pang

10-1 9:05 AM – 9:25 AM
Acetyl Zingerone: A Multi-Pathway Skin Longevity Molecule Targeting AMPK, Nrf2, and the Matrisome
Ratan Chaudhuri

10-2 9:25 AM – 9:45 AM
Innovative Photoactivated Ruthenium Chemotherapy to Treat Eye Cancer: The Translational Journey of a University Researcher
Sylvestre Bonnet

10-3 9:45 AM – 10:05 AM
Advancing Porphyin-Phospholipid Technology
Jonathan Lovell

10:05 AM – 10:30 AM
Coffee Break

10-4 10:30 AM – 10:50 AM
Safety Evaluation and Regulatory Pathways for the Industrialization of Engineered Skin Probiotics
Yong Han

10-5 10:50 AM – 11:10 AM
Lyme Disease, Curly Horses, and Invasive Plants: Translating a Photoantimicrobial for Dental Applications
Colin Cameron

10-6 11:10 AM – 11:30 AM
My Multi-Decade Entrepreneurial Journey in Playing with Light
Sean Wang

10-7 11:30 AM – 11:50 AM
AI-assisted evaluation of translational potential in photochemistry and photobiology
Shiyong Wu

9:05 AM – 12:00 PM Mohave I

ESP-ASP Joint Session: Photosensitization: a Tribute to Professor Miguel A. Miranda

Chairs: Santi Nonell, Sherri McFarland

11-1 9:05 AM – 9:25 AM
Tribute to Prof. Miguel Angel Miranda
Virginie Lhiaubet-Vallet

11-2 9:25 AM – 9:45 AM
DNA photoreactivity and photorepair: the legacy of Miguel A. Miranda
Virginie Lhiaubet-Vallet

11-3 9:45 AM – 10:05 AM
Harnessing Photosensitized Energy Transduction to Develop Non-Native Photoreceptor Proteins
Lorenzo Brancaleon

10:05 AM – 10:30 AM
Coffee Break

11-4 10:30 AM – 10:50 AM
Platinum(II) porphyrin metal-organic frameworks: luminescent tools for optical oxygen sensing in biomineralisation-capable bacteria biofilms
Francesca Giuntini

11-5 10:50 AM – 11:10 AM
Photosensitizer, light and biological response: how many photons are needed?
Lothar Lilge

11-6 11:10 AM – 11:30 AM
Flash Photodynamic Therapy – The use of pulsed laser to saturate photosensitizer absorption and enables selective tumor treatments
Luis Arnaut

11-7 11:30 AM – 11:50 AM
Clustering-triggered photoantimicrobials
Santi Nonell

9:05 AM – 12:00 PM Mohave II

Photobiology Across the Visible Spectrum: Oxidative Stress, Skin Pigmentation, Clinical Responses, Photoprotection, Aging, and Photocarcinogenesis

Chairs: Eduardo Ruvolo, Indermeet Kohli

12-1 9:05 AM – 9:30 AM
Visible Light and Skin Carcinogenesis – What Do We Know?
Curtis Cole

12-2 9:35 AM – 10:00 AM
Risks from Ambient Light – Detection of DNA Damage
Marcus Cooke

10:05 AM – 10:30 AM
Coffee Break

12-3 10:30 AM – 10:55 AM
Clinical Implications of Visible Light
Iltefat Hamzavi

12-4 11:00 AM – 11:25 AM
From Photons to Biology: Mechanistic Insights into Visible Light–Induced Skin Damage and Photoprotection Strategies
Eduardo Ruvolo

12-5 11:30 AM – 11:55 AM
Harmonizing In Vivo Visible Light Phototesting: Methodologic Variability and Consensus Recommendations
Indermeet Kohli

9:05 AM – 12:00 PM Kiva

Structures and Mechanisms of Photoreceptors and Light-sensitive Proteins

Chair: Xiaojing Yang

13-1 9:05 AM – 9:35 AM
Dynamics of mechanism of a dual function of DNA repair and signal transduction by CraCRY protein
Dongping Zhong

13-2 9:35 AM – 10:05 AM
Light-induced structural changes in B12-dependent photoreceptor CarH revealed by temperature-scan crystallography
Zhong Ren

10:05 AM – 10:30 AM
Coffee break

13-3 10:30 AM – 10:55 AM
From femtoseconds to function: integrative spectroscopy to develop novel fast red reversible photoswitchable fluorescent proteins.
Michel Sliwa

13-4 10:55 AM – 11:20 AM
Investigating the solvent specific spectral responses of carotenoids through resonance Raman spectroscopy
Kaustav Das

13-5 11:20 AM – 11:40 AM
Molecular mechanisms of spectrum tuning in far-red photoreceptor
Xiaojing Yang

13-6 11:40 AM – 12:00 PM
Energy transfer from phycobilisomes to photosystems and its regulation
Jindong Zhao

12:00 PM – 12:45 PM Encanto I-II
ASP Executive Council Meeting (ASP Officers only)

12:00 PM – 1:00 PM Paloma I-III
Associate Councilors Election (Associate Members only)

1:00 PM – 1:45 PM Kiva
ASP Business Meeting (open to all)

2:00 PM – 3:00 PM Kiva
Plenary Lectures

PL8 2:00 PM – 2:30 PM
Singlet oxygen dosimetry and light fractionation on PDT efficacy
Tim Zhu

PL9 2:30 PM – 3:00 PM
Reflectin: a protein machine dynamically fine-tuning the color of squid skin for camouflage and communication
Daniel Morse

3:15 PM – 5:15 PM Paloma I-III
Advancing Light Therapy in the Clinical Setting
Chair: Gal Shafirstein

14-1 3:15 PM – 3:35 PM
Advances in photothermal therapy of hematological malignancies
Johannes Zakrzewski

14-2 3:42 PM – 4:02 PM
Photodynamic Therapy for Basal Cell Carcinoma in Clinical Practice
Nathalie Zeitouni

14-3 4:09 PM – 4:29 PM
Challenges and Opportunities in Treating Malignant Central Airway Obstruction with Interstitial Photodynamic Therapy
Nathaniel Ivanick

14-4 4:36 PM – 4:56 PM
An overview and a New Perspective on Light Dosimetry in Photodynamic Therapy
Gal Shafirstein

5:03 PM – 5:15 PM
Panel discussion

3:15 PM – 5:15 PM Mohave I

Computational Photobiology / Quantum Computing in Photobiology

Chairs: Marta Alberto, Antonio Francés-Monerris

15-1 3:15 PM – 3:35 PM
Computational Modelling of Light-Driven Mechanisms in Metal and Metal-Free Photosensitizers for Photodynamic Therapy
Marta Erminia Alberto

15-2 3:35 PM – 3:55 PM
Multiscale Modelling of Emergent Photoactivated Anticancer Therapies
Antonio Francés-Monerris

15-3 3:55 PM – 4:15 PM
Computational studies of potassium-selective channelrhodopsin
Igor Schapiro

15-4 4:15 PM – 4:35 PM
Metal-Based Photosensitizers Design using Quantum Chemical Computational for Photodynamic Therapy
Vijay Krishna

15-5 4:35 PM – 4:55 PM
Quantum computing meets AI: a new frontier for virtual screening of photosensitizers and photocatalysts
Stefan Knecht

15-6 4:55 PM – 5:15 PM
Yellow fluorescent protein: a protein qubit platform for future quantum technologies
Mouzhe Xie

3:15 PM – 5:15 PM Mohave II

UVB-Induced DNA Damage, Repair, and Skin Carcinogenesis

Chair: Veronica Bahamondes Lorca

16-1 3:15 PM – 3:40 PM
Enzyme-coupled Isotope Dilution and Mobility Shift Mass Spectrometry Assays for Non-adjacent DNA Photoproducts
John-Stephen Taylor

16-2 3:40 PM – 4:05 PM
Circadian Rhythm Disruption Amplifies Arsenic and UVB Co-Carcinogenicity in Skin by Altering the Methylation and Transcriptomic Landscape
Shobhan Gaddameedhi

16-3 4:05 PM – 4:30 PM
Is it the same to use any tanning device? Ultraviolet tanning emission from devices located in Spain.
David Baeza

16-4 4:30 PM – 4:55 PM
Endoplasmic reticulum stress impairs Nucleotide Excision Repair capacity and enhances susceptibility to UVB-induced DNA damage
Veronica Bahamondes Lorca

3:15 PM – 5:15 PM Kiva
Frontiers in Photobiology Part 1: Light-Matter Interactions Across Scales
Chair: Elizabeth Gaillard

17-1 3:15 PM – 3:35 PM
Illuminating ultraweak photon emission research for quantum nonlinear biophotonics
Nathan Babcock

17-2 3:35 PM – 3:55 PM
Lanthanide-based complexes for bioimaging and singlet oxygen generation
Ana de Bettencourt-Dias

17-3 3:55 PM – 4:15 PM
Photostability of therapeutic mAbs and ADCs under real-life light doses
Giorgia Miolo

17-4 4:15 PM – 4:35 PM
Photosynthetic bacteria for light-driven energy production and environmental bioremediation
Rossella Labarile

17-5 4:35 PM – 4:55 PM
Programming Nanoscale Matter
Oleg Gang

17-6 4:55 PM – 5:15 PM
Biocompatibility of Non-Aqueous Solvents with Rhodobacter sphaeroides Chromatophores
Claudia Zonno

5:00 PM – 5:15 PM TBD
ASP Group Photo

6:00 PM – 10:00 PM Paloma Garden
Banquet & Awards Ceremony (ticketed event)

8:00 AM – 9:00 AM Kiva
Plenary Lectures

PL10 8:00 AM – 8:30 AM
The Tortoise and the Hare in Photodynamic therapy: How to deliver painless PDT
Edward Maytin

PL11 8:30 AM – 9:00 AM
Ultrafast photophysics in DNA and eumelanin
Bern Kohler

9:05 AM – 10:05 AM Paloma I-III
Photothermal Therapy (PTT)
Chair: Emily Gawrys

18-1 9:05 AM – 9:35 AM
Machine learning–optimized photothermal microparticles for repeatable, localized combination cancer therapy
Litsa Kapsalis

18-2 9:40 AM – 10:00 AM
Buffered saline injection enhance quantum-engineered mid-infrared laser thermal therapy: ex vivo feasibility evaluation
Fatima Toor

10:30 AM – 12:00 PM Paloma I-III
Molecules for Phototherapy and Bioimaging Part 2
Chair: Wenfang Sun

19-1 10:30 AM – 10:50 AM
Overcoming Hypoxia and Photoresistance in Photodynamic Therapy
Tae-Hyuk Kwon

19-2 10:50 AM – 11:10 AM
PaX dyes – photoactivatable fluorophores for live-cell and multicolour nanoscopy
Richard Lincoln

19-3 11:10 AM – 11:30 AM
Perylenequinones: fungal metabolites under the spotlight
Nicholas Oberlies

19-4 11:30 AM – 11:50 AM
TBD

9:05 AM – 10:05 AM Mohave I

Photosensitization Mechanisms and Photoreaction Pathways

Chair: Ryan McCulla

20-1 9:05 AM – 9:25 AM
Development and study of new physiologically useful photoprecursors to hydropersulfides (RSSH)
John Toscano

20-2 9:26 AM – 9:45 AM
Singlet oxygen-cleavable linkers for precision photodynamic therapy and controlled drug release
Youngjae You

20-3 9:46 AM – 10:05 AM
The rare single chromophore dual-release photochemistry of sulfoximines and sulfone diimines
Ryan McCulla

10:05 AM – 10:30 AM
Coffee Break

10:30 AM – 11:30 AM Mohave I

Optogenetics

Chair: Ajith Karunarathne

21-1 10:30 AM – 11:10 AM
Harnessing structure-guided optogenetic tool engineering for advanced Cell Signaling Manipulation
Ajith K Karunarathne

21-2 11:00 AM – 11:30 AM
Understanding Photouncaging of Catechols
Michael Young

9:05 AM – 12:00 PM Mohave II

Ultrafast Dynamics in Photobiology

Chair: Carlos Crespo

22-1 9:05 AM – 9:25 AM
Ultrafast Spectroscopy Systems for Photobiology
Greta Bucyte

22-2 9:25 AM – 9:45 AM
UV Excitation of Uracil Results in the Formation of a Ground-State Intermediate in Less Than One Picosecond and Its Decay is Quenched by Nucleophilic Water Addition
Reshma Mathew

22-3 9:45 AM – 10:05 AM
UV-Driven Selection of Early Life Codons
Corinna L Kufner

10:05 AM – 10:30 AM
Coffee Break

22-4 10:30 AM – 11:00 AM
DNA repair of 6-4 photoproduct by photolyase needs one- or two-photon excitation?
Dongping Zhong

22-5 11:00 AM – 11:30 AM
Teaching An Old Dog New Tricks – Repurposing A Solvent Polarity Probe to Study Complex Chemical Environments
Clemens Burda

22-6 11:30 AM – 12:00 PM
Ultrafast Excited State Dynamics of Silver ion-DNA supramolecular assemblies
Bern Kohler

9:05 AM – 10:05 AM Kiva

Frontiers in Photobiology Part 2: Light-Directed Chemical Control in Biology

Chair: Shobhan Gaddameedhi

23-1 9:05 AM – 9:25 AM
The Potential of Carbon Nanomaterial as New Active Ingredients in Sunscreens
Vijay Krishna

23-2 9:25 AM – 9:45 AM
Light-directed click strategies for permanent or reversible derivatization of biological substrates
Vladimir Popik

23-3 9:45 AM – 10:05 AM
Molecular and biological mechanism studies of protein photooxidation to control cell fate and their therapeutic applications
Mingyu Park

10:30 AM – 12:00 PM Kiva

Trainee Platform I

Chairs: Ge Shi, Alisher Talgatov

24-1 10:30 AM – 10:42 AM
Heterogeneous oxygen dynamics during photodynamic therapy detected with real-time ultrasound-guided photoacoustic imaging for personalized dosimetry
Andrew Langley

24-2 10:42 AM – 10:54 AM
Cholesterol-Dependent Regulation of PHB-1 Nuclear Function and Self-Aggregation Following Solar UV Irradiation in Keratinocytes
Zeinab Fayyaz

24-3 10:54 AM – 11:06 AM
Investigating structure-activity relationships of photoactive metallodrugs as antimicrobials
Gurleen Kaur

24-4 11:06 AM – 11:18 AM
Synthesis and characterization of homoleptic oligothienyl-substituted Ir(III) and Ru(II) bis(terpyridine) complexes: photophysics and photodynamic therapeutic effects
Kalara Develigoda Gamage

24-5 11:18 AM – 11:30 AM
Synthesis and Characterization of Light-Triggered Metal Complexes for Cancer Treatment
Dalton Lucas

24-6 11:30 AM – 11:42 AM
Photochemistry and Mechanistic Studies of Diaryl Sulfondiimine Derivatives
Paul Danyi

24-7 11:42 AM – 11:54 AM
Light Transmission as an Indication for Response to Interstitial Photodynamic Therapy
Chris Lawson

12:00 PM – 2:00 PM Paloma I-III
Peer Mentoring Lunch Session (Associate Members only)

2:00 PM – 3:00 PM Kiva
Plenary Lectures

PL12 2:00 PM – 2:30 PM
ASP Presidential Lecture – From Foundations to Frontiers in Photobiology: Molecules to Medicine with Photoactive Metal Complexes
Sherri McFarland

PL13 2:30 PM – 3:00 PM
Editor's Lecture – Photochemistry and Photobiology
Alexander Greer

3:15 PM – 5:15 PM Paloma I-III
Photodynamic Therapy in Translation: Innovations in Technologies through Techniques

Chair: Theresa Busch

25-1 3:15 PM – 3:35 PM
Understanding tumor microenvironmental priming by palliative radiotherapy to augment response to interstitial photodynamic therapy
Theresa Busch

25-2 3:35 PM – 3:55 PM
Translating targeted photodynamic platforms for immune-dermatology and precision photomedicine
Bryan Spring

25-3 3:55 PM – 4:15 PM
Towards Photoacoustic Imaging-Enabled Personalized Photodynamic Therapy: From Molecular Contrast to Real-Time Oxygen Mapping
Srivalleesha Mallidi

25-4 4:15 PM – 4:35 PM
Photodynamic therapy for targeting microinvasive and drug-resistant head and neck squamous cell carcinoma
Jonathan Celli

25-5 4:35 PM – 4:55 PM
Interstitial Chemo-Phototherapy for Ablating Locally Advanced Cancers
Emily Oakley-Gawrys

25-6 4:55 PM – 5:15 PM
Light-activatable ethyl cellulose ethanol ablation for treatment of tumors and promotion of anti-tumor immune effects
Brian Schnoor

3:15 PM – 5:15 PM Mohave I
Antimicrobial PDT Part 2
Chair: Andres Durantini

26-1 3:15 PM – 3:35 PM
Role of Bacterial Heterogeneity in Modulating ROS-Mediated Antimicrobial Phototherapy
Andres Durantini

26-2 3:35 PM – 3:55 PM
Light-activated silver nanoparticles for inactivation of antibiotic-resistant bacteria and elimination of biofilms
Juan Vivero-Escoto

26-3 3:55 PM – 4:15 PM
Engineering Titanium Dioxide Nanoparticles for Enhanced Antimicrobial Photodynamic Therapy of Biofilm-Associated Infections
Anna Cristina Samia

26-4 4:15 PM – 4:35 PM
Structure–Function Insights into Amino-Flavylium Dyes for Antimicrobial Photodynamic Therapy
Patricia Correia

26-5 4:35 PM – 5:15 PM
Superhydrophobic Burn Wound Dressing: Effect of Irradiance, Fluence, and Photosensitizer Loading on Escherichia Coli Inactivation by Airborne Singlet Oxygen
Chathuna Bodahandi

3:15 PM – 5:15 PM Mohave II

Dermato-Oncology: UV-Induced Skin Carcinogenesis Part 2

Chair: Masaoki Kawasumi

27-1 3:15 PM – 3:39 PM
Genome-wide maps of mutations and UV photoproducts induced by sunlight
John Wyrick

27-2 3:39 PM – 4:03 PM
Loss of CCAAT enhancer binding protein beta transcription factor primes the keratinocyte cGAS-STING response to UVB-induced DNA damage
Jonathan Hall

27-3 4:03 PM – 4:27 PM
Protein tyrosine dephosphorylation signaling in the regulation of UVB-induced epidermal apoptosis
Dae Kim

27-4 4:27 PM – 4:51 PM
Immunosuppression by cyclosporine A accelerates melanoma initiation and progression in BRAFV600E/PTENNull mice
Gagan Chhabra

27-5 4:51 PM – 5:15 PM
RNA modifications in UV stress response and tumorigenesis
Yu-Ying He

3:15 PM – 5:15 PM Kiva

Trainee Platform II

Chair: Gurleen Kaur

28-1 3:15 PM – 3:27 PM
Programmable Photo-Active CPC-like Surfactants as Environmentally Benign Alternatives to Cationic Antimicrobial Agents
Balaka Ghosh

28-2 3:27 PM – 3:39 PM
Optimizing the phototherapy effects of metallodrug photosensitizers for cancer treatment
Ge Shi

28-3 3:39 PM – 3:51 PM
Patterns in Polyphylla: shifts in coloration and pattern in response to climate change
Colton Roberts-Zaffiro

28-4 3:51 PM – 4:03 PM
Comparative evaluation of perfluorocarbon core dependent nanodroplets for enhanced photodynamic therapy in 3D head and neck cancer spheroids
Ronak Shethia

28-5 4:03 PM – 4:15 PM
Photobiological Applications of Light-Activated Metallodrugs
Alisher Talgatov

28-6 4:15 PM – 4:27 PM
Expanding the NIR fluorophore toolbox: A general route to access polymethine-modified Cyanine 9 dyes for deep-tissue imaging
Jared Head

28-7 4:27 PM – 4:39 PM
Cyclic AMP Response Element-Binding Protein (CREB) as a novel biomarker for evaluating photoprotection of photoprotective agents in attenuating skin carcinogenesis
Julianne Nayar

28-8 4:39 PM – 4:51 PM
TBD

5:15 PM – 5:45 PM Kiva
Closing Remarks
Chairs: Sherri McFarland, Ryan McCulla

6:00 PM – 9:00 PM Encanto I-II
ASP Council Meeting (ASP Officers, Councilors, and Associate Councilors only)

ABSTRACTS

SORTED BY LAST NAME OF PRESENTING AUTHOR

Synthesis and characterization of Ir(III) and Ru(II) bis-terpyridine complexes bearing oligothienyl and pyrene-1-yl substituents

Habiba Afrin, Wenfang Sun

The University of Alabama

Photodynamic therapy (PDT) is a minimally invasive cancer treatment that utilizes a photosensitizing agent and light of a specific wavelength to destroy cancer cells selectively. Compared to conventional treatments like chemotherapy and radiotherapy, PDT offers several advantages, including minimal invasiveness, reduced systemic toxicity, high selectivity for tumor tissue, and the ability to preserve normal tissue structure and function. Transition metal complexes have emerged as promising candidates for overcoming some of the limitations of traditional organic photosensitizers (PSs) in PDT. The unique photophysical and photochemical properties of transition metal complexes, such as strong absorption in the therapeutic window, tunable excited-state lifetimes, and the ability to generate ROS via oxygen-dependent and oxygen-independent mechanisms, make them attractive for cancer phototherapy. In this work, a series of Ir(III) and Ru(II) bis-terpyridine complexes bearing oligothienyl and pyrene-1-yl substituents were synthesized and systematically characterized to explore their potential as PDT candidates. The structures of precursors and complexes were confirmed through 1HNMR and mass spectrometry. UV–Vis absorption studies revealed intense ligand localized π–π^* transitions. Photoluminescence measurements demonstrated phosphorescence bands in the red to near-infrared region, with microsecond-range emission lifetimes indicative of efficient triplet population. Their phosphorescence emission was initially attributed to ligand-localized 3π-π^* / 3ILCT. Significantly, phosphorescence quantum yields and singlet oxygen quantum yields were determined, confirming the ability of these complexes to act as effective ROS generators. Transient absorption spectroscopy further revealed excited-state features, characterized by the mixed ILCT/MLCT nature of these complexes. Together, these findings highlight the promise of oligothienyl- and pyrenyl-modified Ir(III) and Ru(II) bis-terpyridine complexes as effective PSs with favorable photophysical properties.

Polo-like kinase 4 progression

Tanya Jaiswal[1], Gagan Chhabra[1], Mary A Ndiaye[1], Hao Chang[1,2], Nihal Ahmad[1,2]

[1]University of Wisconsin

[2]William S. Middleton Memorial Veterans Hospital, Madison, Wisconsin

Cutaneous melanoma is one of the most lethal skin cancers, driven by complex genetic and environmental factors. Ultraviolet (UV) radiation is an established initiator of melanoma through DNA damage. However, the molecular pathways that interact or contribute to UV during melanoma development and progression remain incompletely understood. Polo-like kinase 4 (PLK4), a master regulator of centriole duplication and genomic stability, has emerged as a potential oncogenic driver in certain malignancies. Earlier, we showed a pro-proliferative function of PLK4 in melanoma. However, its exact role and mechanisms in melanoma are not completely understood. In this study, using human melanoma tissues, we found that PLK4 is significantly overexpressed from early to advanced stages compared to normal skin and nevi. Further, employing PLK4 overexpression (OE) and knockout (KO) models of BRafV600E/Pten-/- and UV-induced Tyr-CreERT2:BRafCA mice, we demonstrated that PLK4 OE led to an early onset of melanoma development, accelerated tumor progression, and decreased the survival of mice.

Conversely, PLK4 KO significantly delayed melanoma onset and progression, resulting in a survival advantage. Moreover, PLK4 KO in LOX IMVI cells, a metastatic melanoma model, showed a significant reduction in tumor growth and metastatic potential in NOD/SCID mice. Additionally, using the QIAGEN Cancer PathwayFinder PCR-array analysis of UV-exposed skin of PLK4 OE and KO mice demonstrated several diZerentially expressed cancer-associated genes. Overall, these findings highlight the important roles of PLK4 in the development and progression of UV-induced skin carcinogenesis. Thus, PLK4 could be a promising target for the prevention and early interception of melanoma.

Computational Modelling of Light-Driven Mechanisms in Metal and Metal-Free Photosensitizers for Photodynamic Therapy

Marta Erminia Alberto

University of Calabria, Rende (CS), Italy

Computational methods play a crucial role in advancing light-activated anticancer approaches by providing detailed insights into the electronic structure and photochemical behavior of new promising agents for such applications also guiding their rational design. Among the photoactivated anticancer strategies, photodynamic therapy (PDT) stands out as the most advanced one, although its application is still hindered by some several limits, such as the poor availability of molecular oxygen in many tumor microenvironments. Addressing this challenge requires the development of novel light-responsive agents capable of operating effectively under hypoxic conditions, as well as the exploration of alternative therapeutic mechanisms that do not directly rely on oxygen.

This contribution highlights recent insights derived from DFT/(QR)TDDFT and multiscale computational methods on the distinctive features of selected metal-based and metal-free systems with noteworthy hypoxia activity. Beside the two well-known TypeI/TypeII quenching mechanisms of the excited triplet state of the photosensitizer (^{3}PS) that results in the damage or destruction of living tissues ultimately triggering apoptosis and/or necrosis, our studies also attempt to study the interaction of light-driven molecules with cell membrane through the exploration of the mechanisms underlying insertion into the bilayer core and disruption of membrane structure, highlighting their key roles in the biological activity of several classes of dyes.

Combination of vitamin D with photodynamic therapy for treatment of B16 malignant melanoma in mice

Sanjay Anand[1,2,3], Jacky H.K. Chen[3], Alan S. Shen[3], Cheng-En Cheng[2], Edward Maytin[1,2,3]

[1]Departments of Dermatology

[2]Biomedical Engineering

[3]Cleveland Clinic Lerner College of Medicine of Case Western Reserve University

Malignant melanoma (MM) is a highly aggressive cancer, leading to 104,960 new cases and 8,430 deaths in the U.S. in 2025. Despite major advances in therapies including immune checkpoint inhibition (ICI), melanoma remains a deadly disease with 5-year survival rates of only ~50% for advanced-stage MM. Therefore, effective additional approaches to treat the primary disease and reduce future metastases are urgently needed. Photodynamic therapy (PDT), although routinely used for non-melanoma skin cancers (NMSC), has not yet been explored for treatment of MM. We previously demonstrated that Vitamin D (VitD) combined with PDT exert a powerful immunostimulatory

effect in NMSC models. Here, a combination of VitD and PDT was compared to each treatment alone, for the ability to boost anti-tumor immunostimulation in a B16 melanoma tumor model. Immune response analyses of innate and adaptive immune cells and immune checkpoint molecules were performed using RNA-Seq, immunohistology, and flow cytometry techniques. In addition to known effects on PpIX levels and apoptotic cell death, PDT ± VitD pretreatment induced long-term immunogenic responses within the primary tumor. The results from this investigation suggest that PDT ± VitD boosts anti-tumor immunity and abrogates immune tolerance to melanoma, and points to a future combination approach to boost ICI efficacy and improve management of MM by reducing melanoma metastases.

Structure and Mobility of Photosensitizers in Alginate Films for Photoactive Packaging Applications

J. Alejandro Arboleda-Murillo[1]; Ana Valentina Luna- Obando[2]; Alejandro Gallego-Vargas[1]; Leidy T. Sanchez[3]; Cristian C. Villa[2].

[1]Grupo de Investigación en Fisicoquímica Ambiental y Computacional, Facultad de Ciencias Básicas y Tecnologías, Universidad del Quindío, Armenia, Colombia

[2]Programa de Química, Facultad de Ciencias Básicas y Tecnologías, Universidad del Quindío. Armenia, Quindío, Colombia.

[3]Programa de Ingeniera de Alimentos, Facultad de Ciencias Agroindustriales, Universidad del Quindío. Armenia, Quindío, Colombia.

Alginate-based films functionalized with selected natural and synthetic photosensitizers—rose bengal, riboflavin, curcumin, and quercetin—were investigated for their potential application in photoactive food packaging systems. The films were systematically characterized using confocal laser scanning microscopy (CLSM) and steady-state fluorescence spectroscopy to elucidate their structural organization and optical behavior. Z-stack CLSM imaging was employed to evaluate the spatial distribution, penetration depth, and homogeneity of the photosensitizers within the alginate matrix. In addition, fluorescence recovery after photobleaching (FRAP) experiments were performed using food simulants A (aqueous) and B (alcoholic) to estimate the diffusion dynamics and molecular mobility of the embedded photoactive compounds. Steady-state fluorescence emission and excitation spectra provided insights into the photophysical stability and excitation profiles of each photosensitizer when incorporated into the biopolymeric matrix. The results revealed distinct differences in distribution patterns and diffusion behavior depending on the chemical nature of the photosensitizer. In particular, rose bengal and curcumin exhibited deeper penetration into the film structure and higher fluorescence intensity, suggesting stronger interactions with the alginate network. Overall, these findings support the rational design of photoactive packaging materials with tunable optical properties and controlled mobility of active compounds. The combined application of CLSM and fluorescence spectroscopy constitutes a robust analytical platform for understanding the behavior of light-responsive molecules in biodegradable films intended for food preservation and safety applications.

Exploring antimicrobial photodynamic therapy as a treatment option for complicated urinary tract infection

Brian S. Learman, Aimee L. Brauer, Chelsie E. Armbruster

Jacobs School of Medicine and Biomedical Sciences, State University of New York at Buffalo

Urinary tract infections (UTIs) are among the most common infections worldwide, and effective treatment can be challenging. For example, antibiotic treatment in patients with indwelling catheters can fail to achieve sterilization of the urine and species disrupted by treatment often re-appear, indicating the presence of a reservoir that is not eradicated by standard treatment. The objective of this study was to evaluate the efficacy of antimicrobial photodynamic therapy (aPDT) to provide lasting eradication of bacterial biofilms on urinary catheters and against quiescent intracellular reservoirs (QIRs) of bacteria within bladder epithelial cells. TLD1433 was selected as the photosensitizer due to its application within the urinary tract for treatment of invasive bladder cancer.

Sterile size 14 French Foley catheters were cut into 10 mm segments, inoculated with bacteria (single-species and polymicrobial combinations), and incubated at 37°C for 24 hours to form biofilms. Catheter biofilms were then subjected to two rounds of an aPDT treatment regimen consisting of 30 minute exposure to 25 μM TLD1433 (equivalent to

~7 μg/cm2, 1000-fold lower than the dose being used in clinical trial for bladder cancer) and illumination with a continuous wave 405 nm light emitted diode for 30 minutes to achieve ~100 J/cm2 at the catheter surface. This regimen reduced viability of all tested bacteria to the limit of detection, but a combination treatment with antibiotics was required to achieve lasting sterility. In contrast, a single round of aPDT was effective at eradicating QIRs. Ongoing studies are focused on preclinical optimization of the aPDT treatment regimen.

Flash Photodynamic Therapy – The use of pulsed laser to saturate photosensitizer absorption and enables selective tumor treatments

Luis G. Arnaut

CQC-IMS, University of Coimbra, Portugal

FLASH therapies are attracting tremendous interest because they spare normal tissues while maintaining tumor-destroying efficacy, when compared with continuous delivery of radiation. In Photodynamic Therapy (PDT), it has been noted that continuous-wave and pulsed lasers give comparable efficacy in a variety of tumors but the increased tumor-to-peritumoral tissue selectivity have never been investigated. We present a model that predicts how pulsed lasers, in combination with photosensitizers, can offer selective and in-depth tumor ablation. The model is based on the saturation of photosensitizer absorption to obtain the FLASH effect. The importance of the number of laser pulses to destroy tumor tissue and spare normal tissue is demonstrated. The predictions of the model and the superiority of FLASH-PDT are demonstrated with the treatment of subcutaneous CT26 and orthotopic 4T1 tumors models. Notably, FLASH-PDT with redaporfin significantly increases overall survival of mice with 4 mm orthotopic 4T1 tumors and lung metastasis, and elicits cures. FLASH-PDT allows for the use of order-of-magnitude higher drug or light doses without affecting healthy tissues, while promoting selective and deeper tumor treatments.

Linking ligand architecture to antimicrobial efficacy in Ru(II)-based photosensitizers for Photodynamic Therapy

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Ru(II) complexes are promising photosensitizers for antimicrobial photodynamic therapy (aPDT) owing to their tunable photophysical properties, high stability and selective targeting towards microbial cells, together with low resistance development. A series of heteroleptic Ru(II) N-donor complexes, combining different N-bidentate ligands, were synthesized to evaluate their potential as photosensitizers for aPDT. All complexes generated singlet oxygen upon visible light irradiation and efficiently photoinactivated Staphylococcus aureus at micromolar concentrations. Among them, Complex 2, bearing two phenanthrolines

and one pyridine–pyrazole ligand, exhibited the most encouraging aPDT profile due to its optimized ligand structure, which enhances optical properties and singlet oxygen production. It penetrates the bacterial cytoplasm and damages genomic DNA, effectively inactivating both Gram-positive and Gram-negative bacteria and, to a lesser extent, Candida albicans yeasts, while remaining non-toxic to human fibroblasts at therapeutic relevant doses. Overall, these findings establish clear structure–activity relationships linking ligand architecture to biological performance and provide robust design principles for the rational selection of ligands in the development of efficient and selective Ru(II)-based aPDT agents. By directly correlating molecular structure with biological function, this work represents an important step towards innovative antimicrobial strategies to combat antibiotic-resistant infections.

Engineering Smart Light-active Sulfur-based Bioactive Platforms and Hybrid Nanomaterials to Pioneer Synergistic Photobiomedical Applications & Public Health Improvement

Sarita Rawool, Balaka Ghosh, and A. Jean-Luc Ayitou*

University of Illinois Chicago

Sulfur-containing platforms exhibit unique physicochemical properties, including light-harvesting/responsiveness and antimicrobial properties that can be tailored for synergistic biomedical applications. Recent efforts in our lab have led to the creation of several sulfur-containing heterocyclic chromophores, amphiphiles, and hybrid nanomaterials that can be synergistically emissive, photo-toxic, or generate cytotoxic oxygen species (ROS). Beyond the canonical sulfur effect, we demonstrated that intrinsic, viz., molecular properties and supramolecular architecture, can enable combined mechanisms of action, such as enhanced ROS generation, inhibition of several bacterial strains at low concentration (MIC), and release of valuable bioactive fragments. Using advanced analytical and photophysical tools, we performed the comprehensive characterization of our molecular, amphiphilic, and hybrid materials. Biological evaluation includes in vitro cell viability assays (on dendritic cells), MIC, and time-kill kinetics on several Gram-positive and Gram-negative human and foodborne pathogens, leading to the identification of lead candidates with favorable therapeutic indices.

My presentation will (i) detail the photophysics and photochemistry of new sulfur-based photodynamic agents, antimicrobial amphiphiles, and theragnostic hybrid nanomaterials; and (ii) showcase synergistic bioactivity, antimicrobial performance, photoluminescence-guided photodynamic therapy, and programmable release of tailored fragment(s). Our research establishes a new design principle for next-generation sulfur-containing photosensitizers, photo-materials, and nano-therapeutics for precision photobiological and theragnostic applications.

Illuminating ultraweak photon emission research for quantum nonlinear biophotonics

Nathan S. Babcock

Human Frontier Collective, Scale AI, San Francisco, CA, Quantum Biology Laboratory, Howard University, Washington, DC

The interface between quantum mechanics and biology constitutes one of science's most dynamic research frontiers. A fundamental reciprocity emerges at this interface: whereas quantum mechanics illuminates molecular biology, living systems harbor unexplored quantum mechanical phenomena—a central theme in recent theoretical work on the Physical Principles of Quantum Biology.

This presentation brings new perspective on century-old photobiological questions through the lens of contemporary quantum theory. The discovery of biophotons, also known as ultraweak photon emissions (UPE), in the 1920s by Alexander Gurwitsch laid the foundation for the modern fields of biophotonics and UPE research. His predictions of nonlinear quantum optical eXects in biological systems pre-dated comparable discoveries in quantum optics and photonics by decades. The theoretical gap between Gurwitsch's photobiological claims and the quantum mechanical foundations needed to reproduce them experimentally left room for fundamental discoveries at the frontier of research in quantum biology today.

Classical nonlinear optical eXects are now established so thoroughly in biology that they provide the basis for common biophysics experiments and biomedical applications. Although the photochemistry of 350–1300 nm wavelength UPE is similarly well-established, a quantum optical model of ultraviolet (190–250 nm wavelength) UPE from living cells was recently proposed. This model paves the way for future theoretical developments enabled by advances in low-coherence nonlinear optics, non-Hermitian quantum theory, multi-scale modeling, hybrid quantum-classical computing, and machine learning methods. Broader implications span biomedicine, biotechnology, and nanotheranostics, fundamentally reshaping our understanding of light-matter interactions in living systems.

Circadian rhythms of the retina and the skin

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Following the discovery of the non-visual elects of light and the existence of circadian rhythms, understanding the daily rhythms of our internal organs is one of the great challenges for the scientific community. The retina is composed of multiple layers made up of interconnected cells and neurons that express circadian gene proteins. The skin exhibits cyclical mechanisms involving cells from its dilerent layers and perfectly synchronized systemic circadian processes. Studying the skin's circadian rhythms could be key to protecting against the negative elects of ultraviolet radiation, preventing and slowing aging, and aiding in the treatment of chronic diseases such as psoriasis and atopic dermatitis. The cyclical processes of the retina appear to be regulated by melatonin at night and dopamine during the day. The presence of chromophores in other structures of the eye besides the retina suggests a more complex response to light across the dilerent ranges of the visible spectrum. Understanding its influence on eye development could be extremely useful for treating retinal pathologies more electively and precisely, and for deepening our understanding of the causes of myopia progression in order to electively alleviate it. The potential use of light for therapeutic purposes in skin and eye disorders or pathologies calls for further research to achieve greater precision in the manufacture of new light sources with a specific spectral irradiance for each situation.

Is it the same to use any tanning device? Ultraviolet tanning emission from devices located in Spain.

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Indoor tanning can occur through the use of different horizontal, facial, or vertical devices with emitters with different effective irradiances. The objectives of this study were to analyze the irradiances of UV emitting devices used for tanning in the Spanish market so that, from this irradiance, we could calculate the exposure time needed to exceed one MED (minimal erythemal dose) by skin type, and as well as the definition of the variables that affect UV tanning devices. Due to multiple variables based on manufacturing control, spectral distribution and irradiated intensity, tanning and erythematic damage will be different and can be applied to any skin type the same doses. The analysis of

the results concluded that due to the variability in the spectral distribution of UV rays of the tanning devices measured at Spanish facilities and the difficulty detecting changes in lamp configurations, the measurement of effective irradiance could be essential during periodic inspections of indoor tanning facilities, as well as when the UV-emitting lamps are changed, in order to achieve better protection of users and as the only way to know the effects of artificial UV radiation on people.

Endoplasmic reticulum stress impairs Nucleotide Excision Repair capacity and enhances susceptibility to UVB-induced DNA damage

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Environmental pollutants are widespread stressors that contribute to increased carcinogenic risk and disrupt cellular proteostasis by inducing endoplasmic reticulum (ER) stress and activation of the unfolded protein response (UPR). Co-exposure to ER stressors and ultraviolet B (UVB) radiation compromises the removal of UV-induced DNA photoproducts by nucleotide excision repair (NER). Accordingly, environmental pollutants such as benzo[a]pyrene and particular matter may modulate NER activity through ER stress, thereby increasing susceptibility to UVB-driven skin carcinogenesis. In this study, we investigated how ER stress induced by chemical and environmental factors aPects NER ePicacy and contributes to carcinogenic risk. We hypothesized that combined exposure to UVB and exogenous ER stressors exacerbate carcinogenic risk through UPR-dependent regulation of core NER factors. Human keratinocyte (HaCaT) cells were exposed to UVB irradiation (100 J/m²) in the presence or absence of pharmacological ER-stressors and environmental pollutant. DNA photoproducts repair capacity and protein levels of ER stress markers and NER factors were assessed at multiple time points post-irradiation.

Induction of ER stress delayed the removal of UVB-induced DNA photoproducts, including 6–4 photoproducts and cyclobutane pyrimidine dimers, and was associated with reduced expression of core NER proteins. These findings suggest ER stress as a critical modulator of NER ePiciency and further provide mechanistic insight into how environmental stressors may enhance susceptibility to UVB-driven photocarcinogenesis.

Superhydrophobic Burn Wound Dressing: Effect of Irradiance, Fluence, and Photosensitizer Loading on Escherichia Coli Inactivation by Airborne Singlet Oxygen

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Burn wounds present serious physiological challenges, often complicated by bacterial infections that delay healing and increase morbidity. The rise of antibiotic-resistant bacteria has limited the effectiveness of traditional antimicrobial therapies, emphasizing the need for alternative treatments. Antimicrobial photodynamic therapy (aPDT) offers a promising solution by using a photosensitizer (PS) activated by light to generate reactive oxygen species (ROS), such as singlet oxygen (1O2), which destroy pathogens. However, conventional aPDT faces challenges including bacterial resistance to PS uptake, PS selectivity for specific bacterial types, and oxygen limitations in hypoxic tissues.

To address these issues, we developed a novel dressing in which the PS is immobilized on a free-standing superhydrophobic (SH) polydimethylsiloxane (PDMS) membrane. This design prevents PS transfer to the wound while allowing light to be transmitted through the membrane and oxygen to reach the PS via channels in the surface microstructure. The study evaluates the efficacy of airborne 1O2 generated from this SH-aPDT dressing using an ex-vivo porcine skin burn model infected with Escherichia coli (ATCC 25922). Zinc perfluorophthalocyanine, a photostable PS, was coated onto the SH-PDMS surface and irradiated with red LED light to generate gas-phase 1O2. 1O2 generation was quantified using the trapping agent uric acid in aqueous solution, and treatment effectiveness was assessed by colony-forming unit (CFU) reduction as a function of light irradiance, fluence, and PS loading. Reduction in CFU counts ≥

2.0 logs demonstrates the potential of this SH-aPDT dressing as an effective means to prevent bacterial infections without promoting the development of drug-resistant pathogens.

Innovative Photoactivated Ruthenium Chemotherapy to treat eye cancer: the translational journey of a university researcher

Sylvestre Bonnet

Leiden Institute of Chemistry, Leiden University, The Netherlands

Uveal melanoma (UM) is a rare ocular cancer. Current treatments often result in a reduced quality of life for patients, frequently causing vision loss, and approximately 50% of patients ultimately die from liver metastases. The European PACT4EYE project (www.pact4eye.eu) aims to translate a novel treatment approach, known as photoactivated chemotherapy (PACT), into clinical practice for the treatment of UM. This approach employs a newly developed, patented ruthenium-based prodrug (Ru-MTI) that becomes toxic only upon activation by visible light. In this presentation, I will focus on the challenges encountered and opportunities identified in translating fundamental academic research into patient care—that is, bringing it to market.

Financial support by the European Research Council (Starting Grant, Proof-of-Concept grants) and EIC (Transition grant) is gratefully acknowledged.

Ruthenium-based photoactivated chemotherapy for the treatment of cancer: recent developments

Sylvestre Bonnet

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PhotoActivated Chemotherapy (PACT), like PhotoDynamic Therapy (PDT) and photopharmacology, aims at activating anticancer medicines with visible light to circumvent to the tumour site the toxicity of traditional chemotherapy. PACT, however, makes use of special inorganic cages based on ruthenium(II) that can be removed with visible light. In the dark, these cages „hide" the biological function of protein inhibitors, but upon visible light irradiation they are removed irreversibly to recover the toxic inhibitor. Unlike molecules used in PDT that require O2 activation to deliver phototoxicity, Ru-based PACT agents are activated by an O2-independent bond-cleavage reaction. Therefore, our group develops them in the specific context of hypoxic (O2-poor) tumors, where PDT typically fails. In this presentation, several fundamental chemical and biological properties of Ru-based PACT compounds will be presented. We will also show our most recent in vivo results on this family of compounds, and

discuss the challenges to face before clinical applications can become a reality.

Financial support by the European Research Council (Starting Grant, Proof-of-Concept grants), EIC (Transition grant), and NWO (VIDI, VICI grants) is gratefully acknowledged.

Harnessing Photosensitized Energy Transduction to Develop Non-Native Photoreceptor Proteins

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Photoreceptor proteins (PrPs) are nature's extraordinary molecular machines for converting light into biochemical signals, enabling vision, phototaxis, circadian regulation, and more. They also provide an elegant and efficient template for non-native applications. Their molecular operation is fundamentally a photomechanical transduction process, in which photon absorption by a photosensitizer triggers a cascade of events leading to conformational changes in the protein host. The mechanisms that connect these photophysical events to structural changes represent a fascinating area of fundamental biophysics. While natural PrPs exhibit a functional repertoire shaped by evolutionary constraints on chromophore chemistry and protein architecture, non-native photoreceptor proteins (NNPrPs) can bypass these limitations, potentially enabling novel functional biomaterials. However, replicating the PrP concept in NNPrPs poses significant but scientifically stimulating challenges, including precise placement of photosensitizers within the protein scaffold, elucidation of quantum and classical steps underlying energy transduction, and characterization of the physicochemical mechanisms driving protein conformational changes. This presentation introduces a strategy to engineer NNPrPs by harnessing photosensitized energy transduction through photoactive cofactors embedded in proteins lacking native light-dependent functions. By incorporating photosensitizers into non-photoreactive hosts, we create hybrid systems capable of initiating light-driven processes. Using UV–Vis spectroscopy, laser excitation, and time-resolved photophysics, we investigate how protein microenvironments govern photoinduced energy transduction. This approach opens new avenues for light-modulated functional biomaterials, bridging natural photobiology and engineered photochemistry.

Chemical excitation of electrons beyond skin & melanin: retina, hormones, neurotransmitters

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Chemiexcitation differs from photoexcitation: Instead of energy exciting a ground-state singlet molecule to a higher energy singlet state, a chemical reaction product is born in the excited state by deforming a molecule's energy levels. The process relies on geometrical twisting and cleavage of a –C–O–O–C– peroxide ring, rather than photon absorption peaks. In bioluminescent organisms, the molecule is optimized to produce singlet states and light. In mammals, we discovered a similar chemistry that chemiexcites the skin pigment melanin directly to a long-lived triplet state, with most energy dissipated by collisional Dexter energy transfer to molecules such as DNA. The process can be initiated by oxidases or by activation of enzymes producing superoxide and nitric oxide, ultimately creating the peroxide ring on a biomolecule and thence mutagenic and lethal cyclobutane pyrimidine dimers – for hours after brief UVB or UVA exposure triggers radical production. Since then, other laboratories showed that these events occur in human skin, even after violet light, and we found the same chemistry operating on indoles and catechols including the neurotransmitters serotonin and dopamine and the hormone melatonin. Translational applications are beginning to emerge. Chemiexcitation and its detrimental sequelae can be quenched by a range of biomolecules having delocalized electrons.

Conversely, melanin in the young retina appears to protect against age-related macular degeneration; a synthetic peroxide ring bypassed the melanin requirement, degrading the retinal lipofuscin granules that characterizes the disease. Other laboratories are developing chemiexcitation as lightless photodynamic therapy, able to act deep inside tissue.

Ultrafast Spectroscopy Systems for Photobiology

Greta Bučytė, Paulius Baronas

Light Conversion, Vilnius, Lithuania

Ultrafast laser spectroscopy provides a window into photoinduced processes in materials science, photophysics, and photobiology on femtosecond to nanosecond timescales, enabling direct observation of light harvesting, photoprotection, and related pathways. Pump–probe spectroscopy, in particular, can access both emissive and nonemissive excited states and is well suited to quantifying energy transfer in complex samples. Achieving this, however, places strict demands on the experiment: suGicient time resolution, broad UV–NIR spectral coverage, low noise, and long-term stability of laser power, beam pointing during multi-hour measurements of weak, scattering samples. Historically, meeting these requirements often forced researchers to become laser specialists, building and maintaining fragile, homebuilt pump–probe setups with demanding alignment. As a result, the techniques remained underused in many laboratories. Recent turnkey transient absorption platforms are changing this landscape by making ultrafast measurements practical for everyday use. Integrated, commercially available systems reduce alignment overhead, improve reproducibility between users, and shorten the path to publishable data.

Synthesis and Photophysical Studies of Pyrrolopyrrole Cyanine Boron Difluoride Derivatives for Tunable Near-Infrared Absorption and Emission for Biomedical Applications

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Near-Infrared (NIR) absorbing and emitting dyes have gained significant attention in biomedical applications such as bioimaging, photothermal and/or photodynamic therapy, due to their ability to penetrate biological tissues deeply with minimal scattering and absorption. Among the available NIR dyes, pyrrolopyrrole cyanine (PPCy) boron difluoride complexes stand out for their high molar absorptivity and fluorescence quantum yield, making them promising candidates for bioimaging applications. In this work, we report the synthesis and characterization of a series of π-extended PPCy derivatives with 1-3 oligothienyl rings orthogonally tethered to the backbone of the PPCy ligand for tuning the NIR absorption and emission. With the increased numbers of the thienyl rings, the absorption and emission of the complexes were further red shifted. Their biomedical applications in imaging and therapy will be studied later.

Photodamage in Models of Human Corneas Exposed to UVC light

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Far-UVC wavelengths (200–235 nm) effectively inactivate pathogens while causing minimal harm to human skin and eyes due to their limited penetration into biological tissues. Thus, far-UVC sources could operate continuously in

occupied indoor venues to reduce the risk of transmission of infectious diseases. To inform safety guidelines that are based on peer-reviewed data, this study aimed at characterizing the UVC-induced damage in human corneas as function of wavelength. A monochromatic system was used to expose a 3D human corneal model to 100 mJ/cm2 from mono-wavelength from 215 to 255 nm. At each wavelength, yields of cells showing DNA photodamage, their distribution in the corneal epithelium, as well as other markers of cell and tissue integrity were measured. Unlike relatively longer wavelengths, far-UVC wavelengths induced damage only in the uppermost layers of the corneal epithelium. To validate these findings, the anterior section of donated live human corneas was exposed to 50 or 100 mJ/cm² from either a 222 nm filtered KrCl lamp or 254 nm low-pressure mercury lamp. Confocal microscopy was used to measure the depth of the induced DNA damage 30 minutes after exposure. Consistent with the results obtained with the 3D model, acute exposure from either wavelength produced DNA damage that was confined to the superficial epithelium, with 222 nm penetrating less deeply into the human corneas. Our results show that far-UVC wavelength do not damage the critical basal layer of the cornea, supporting their potential use in occupied spaces within the recommended safety guidelines.

Enhancing Photodynamic Therapy with Cancer-Targeted Nanoparticles

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Photodynamic therapy (PDT) is well known as a minimally invasive, highly selective cancer treatment. However, challenges such as hydrophobic photosensitizers, limited tumor selectivity, and poor light penetration into deep tissues restrict its broader application. Recent developments in nanotechnology, particularly the use of gold nanoparticles (AuNPs), offer transformative solutions to these limitations. AuNPs provide a stable, biocompatible platform for photosensitizer delivery, enhancing solubility, stability, and tumor-targeted uptake while minimizing off-target effects. Functionalized AuNPs exploit mechanisms such as the enhanced permeability and retention (EPR) effect and active targeting, thereby significantly improving ROS generation and therapeutic efficacy. This presentation highlights innovations in AuNP-based PDT systems, including ligand-functionalized nanoparticles, bioresponsive coatings, and theranostic approaches, which combine diagnostic imaging with therapy. Advancements in ligand-targeted AuNPs, exemplified by prostate-specific membrane antigen (PSMA)-functionalized systems, have demonstrated increased therapeutic precision and efficacy in-vivo. These advancements contribute to the development of more targeted cancer treatments, positioning AuNP-based PDT systems as a groundbreaking approach for delivering safer, more precise, and highly effective oncological therapies. I will describe our efforts toward targeted nanoparticles for efficient drug delivery to tumors, followed by image-guided photodynamic cancer therapy. The drug delivery time required for targeted therapeutic action has been dramatically reduced from days to hours by using NP-conjugates. Examples from our recent research producing enhanced uptake, targeted therapy, and increased therapeutic efficacy will be presented and discussed.

Teaching An Old Dog New Tricks – Repurposing A Solvent Polarity Probe to Study Complex Chemical Environments

Clemens Burda

Case Western Reserve University, Cleveland

Reichardt's dye betaine-30 (B30) has been a spectroscopic solvent polarity probe for over 60 years.1 Thirty years ago, a shift in its use was pioneered by the group of Paul Barbara, who presented B30 as an ultrafast solvent dynamics probe.2 Their reporting was limited to simple and pure solvents. We have used femtosecond transient absorption spectroscopy to resolve excited state dynamics in complex solutions, identifying patterns of viscosity, the role of water, and other solvent components.3,4 Transient ground-state absorption bleaching (GSB), stimulated emission (SE), and excited-state absorbance (ESA) were measured for B30 in the first excited singlet state (S1) with femtosecond time resolution. In viscous solvent environments and in deep eutectic solvents with intermediate viscosities, SE is seen to the red of the ground-state absorption band and ESA at shorter wavelengths. In contrast, SE is not seen in nonviscous solvents, while both GSB and ESA are prominent. For typical low-viscosity solvents B30 is known to be non-fluorescent. However, we found that B30 fluorescence is detectable at room temperature in high-viscosity environments and it increases as the temperature is lowered. The absence of SE and fluorescence in nonviscous solvent systems is consistent with previous suggestions that S1 can relax to a conformation in which radiative transitions to the ground state (S0) are forbidden. Viscous solvents evidently suppress this relaxation. Time-dependent DFT calculations for B30 in various solvents show that the relaxed S1 configuration is indeed a twisted intramolecular charge transfer (TICT) state. Molecular orbitals, excitation energies, and oscillator strengths were calculated. As the photoexcited molecule twists, the oscillator strength for the S1-S0 transition decreases. Excitation from S0 to S1 has substantial π–π^* character in the ground-state conformation but becomes almost entirely a charge-transfer transition as S1 relaxes to its TICT state, accounting for the loss of oscillator strength for fluorescence. The need for rearrangement of the solvent explains the sensitivity of the relaxation to viscosity, composition, and temperature.

Photophysical Studies on the Temperature-Dependent Photochromism of Reichardt's Dye Betaine-30

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Understanding local solvent polarity and its temperature dependence is critical in biological and photo-biomedical environments, where complex and dynamically evolving media, such as biofluids, lipid- and protein assemblies, as well as other complex molecular mixtures, govern physical and chemical processes. Reichardt's dye B30 is a well-established solvatochromic probe, yet its utility under non-ambient and variable temperature conditions relevant to biomedical applications remains insufficiently explored. Here, I demonstrate that analyzing temperature-dependent solvatochromic absorption measurements of B30 provides quantitative access to solvent polarity, related reorganization energies, free energies, and entropies in solvents spanning a wide polarity range. The shifts in excitation energies and spectral width enabled the direct extraction of solvent reorganization parameters and revealed that entropy contributions from solvent structuring play a major role in determining effective polarity, particularly at low temperatures. These measurements underscore the need for thermodynamically informed approaches to determine solvent polarities in complex media. These findings establish B30 as a robust optical reporter of solvent polarity and solvent organization in variable-temperature environments. The approach is directly extendable to heterogeneous systems, offering a valuable framework for probing local polarity effects in contexts such as imaging, phototherapy, and biomolecular solvation dynamics.

Understanding Tumor Microenvironmental Priming by Palliative Radiotherapy to Augment Response to Interstitial Photodynamic Therapy

Theresa M. Busch[1], Joann Miller[1], Shirron Carter[1], Min Yuan[1], Julia Greer[2], Christopher Lawson[3], Emily Oakley[3], Craig Brackett[3], Nathaniel Ivanick[3], Alan Hutson[3], Keith A. Cengel[1], and Gal Shafirstein[3]

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The addition of interstitial photodynamic therapy (I-PDT) to palliative radiotherapy (p-RT) may provide a novel avenue for achieving durable local tumor control in refractory lung cancer, where current interventions are largely limited to short-lived palliation without sustained response. I-PDT can be incorporated into p-RT regimens for extrabronchial thoracic disease to introduce the possibility of meaningful tumor control in a population with few effective local options. This work investigates how p-RT modulates tumor response to I-PDT, with emphasis on radiotherapy-induced changes to the tumor microenvironment. In preclinical Lewis Lung carcinoma models, p-RT followed by I-PDT yields tumor control that significantly exceeds that achieved with I-PDT alone, consistent with a synergistic interaction between these modalities. Functional MRI and photoacoustic imaging demonstrate that p-RT increases tumor perfusion and local total hemoglobin concentration. To understand the basis of these changes, ongoing immunohistochemistry is defining p-RT-induced alterations in the vascular microenvironment, while flow cytometry of innate immune subsets and optical imaging of vascular temporal dynamics are being used to relate microenvironmental changes to the timing of p-RT fractionation and I-PDT. Collectively, these studies support a strategy in which p-RT is leveraged not only for symptom relief but also as a microenvironmental primer that conditions tumors for improved response to I-PDT. The resulting data will complement observations from an ongoing clinical trial and help guide translation of this combinational approach for patients with solid malignancies refractory to current standard of care therapies.

DNA photochemistry: from model compounds to living systems

Jean Cadet

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The isolation and characterization of cyclobutadithymine (Thy<>Thy) as a stable UVC-induced thymine modification in 1960 have given a strong impetus to the development of extensive studies on DNA photochemistry. This was rapidly accompanied by the detection of Thy<>Thy in UVC-irradiated bacterial cells and subsequent discovery of DNA repair mediated by nucleotide excision and photolyase-mediated reversal pathways. Our contribution that started in the mid 70's to this still dynamic field of research has been pursued over almost 50 years along five main directions in close collaboration with worldwide research groups. 1) Mechanistic and structural studies on the main direct UV-induced DNA damage (bipyrimidine photoproducts, photohydrates and pyrimidine O6,5'-cyclo-5,6-dihydro-2'-deoxynucleosides). This was completed by the measurement of the formation and assessment of repair kinetics of individual base lesions in cells and human skin using sensitive and accurate HPLC based methods. 2) Photosensitization studies involving mono and bi-functional psoralens used in UVA phototherapy (PUVA) with the first evidence of the fast removal of 3-carbethoxypsoralen furan-side mono-adducts to thymine in UVA-irradiated cellular DNA. 3) Photosensitized oxidation reactions of both pyrimidine and purine bases that are implicated in the UVA and visible light photooxidation of cellular DNA. 4) Bi-photonic ionization of purine and pyrimidine nucleobases under high intensity 266-nm laser irradiation that mimics one-electron oxidation reactions of type I photosensitizers and direct effect of ionizing radiation. 5) Singlet oxygen oxidation reaction (type II photosensitization mechanism) of DNA that essentially targets guanine with the exclusive formation of 8-oxo-7,8-dihydroguanine, a ubiquitous DNA oxidatively generated modification.

Lyme Disease, Curly Horses, and Invasive Plants: Translating a Photoantimicrobial for Dental Applications

Colin G. Cameron, Sherri A. McFarland, Susan M. A. Monro, Martin Greenwood, Alexander McLellan

Photodynamic, Inc., Halifax, NS Canada

This talk will describe the serendipitous discovery and development of a photoantimicrobial platform originating from plant-derived extracts. Following a chance interaction involving Lyme disease and Curly horses, these extracts were identified, systematically studied, and repurposed as potent light-activated antimicrobials. This work led to the founding of PhotoDynamic, Inc. and the exploration of multiple applications, including mitigation of oral biofilms for dental use. Two clinical studies have been completed, culminating in a commercial product, with ongoing efforts expanding the platform to highly resistant acne and equine squamous cell carcinoma.

Photodynamic therapy for targeting microinvasive and drug-resistant head and neck squamous cell carcinoma

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Recurrent head and neck cancers are associated with increased risk of metastasis and poor prognosis, with median overall survival rates ranging from 10 to 15 months. The progression of invasive disease that can escape local treatment is driven in part by tumor-microenvironment interactions, which can also contribute to drug resistance. Recent translational studies led by ourselves and others have shown that photodynamic Therapy (PDT) is effective for local treatment of early stage head and neck cancers, especially in the oral cavity. Motivated by the importance of targeting micro-invasive and/or drug resistant disease we have developed in vitro 3D models which recapitulate early events in invasive progression from a primary oral squamous cell carcinoma (OSCC) tumor spheroid transplant into a local fibrotic collagen-rich reconstituted microenvironment. Here we demonstrate this model system to evaluate differential response to aminolevulinic acid (ALA) PDT in primary tumors and peripheral ECM-infiltrating cell populations. We show that invasive cells exhibit phenotypic traits consistent with increased epithelial-mesenchymal transition (EMT) and drug resistance. Invading cells also exhibit increased sensitivity to PDT relative to the primary spheroid mass. These results mirror findings from a previous study in our lab in which we generated, and fully sequenced, a drug-resistant pancreatic cancer sub-line which is shown to exhibit increased EMT and dramatically increased response to PDT relative to the drug-naïve parental cells. Mechanistic investigations examining differential expression of genes that may account for increased sensitivity to PDT in EMT populations are ongoing. Taken together these results point to the potentially important role of PDT in eradicating problematic microinvasive disease which could otherwise contribute to recurrence and metastatic progression.

Clinical Applications for Photodynamic Therapy Inside the Body: The Challenges of Putting PDT Where the Sun Doesn't Ordinarily Shine

Keith A. Cengel, MD, PhD

Photodynamic therapy (PDT) for deep-seated tumors faces significant challenges from limited light penetration. For internal tumors requiring 5-10 cm treatment depths with infrared light

attenuation of 10!" to 10!#, tumor-to-normal tissue drug selectivity must exceed 10"—an order of magnitude greater than current targeted therapies.

Mechanical Light Delivery Approaches: Delivering light to deep tumors requires innovative mechanical solutions. Endoscopic applications enable treatment of endobronchial lung and endoluminal gastrointestinal malignancies. Our custom light applicators treat severe anal dysplasia in HIV patients using oral aminolevulinic acid (ALA) with vitamin D. Vitamin D pretreatment amplifies immunogenic cell death markers, increases intratumoral immune cell infiltration, and reduces PD-1 expression, enhancing antitumor immunity with potential chemotherapy and checkpoint blockade synergy.

Intracavitary delivery encompasses intrapleural and intraperitoneal PDT for malignant pleural mesothelioma, lung cancer pleural spread, and peritoneal dissemination of ovarian, sarcoma, and gastrointestinal malignancies. Extended pleurectomy-decortication with intraoperative PDT yields nearly three-year median survival for epithelial mesothelioma. Infrared navigation systems enable real-time treatment guidance, optimizing light fluence and reactive oxygen species generation. The combination of PDT with immunotherapy addresses surgically-induced immunosuppressive tumor microenvironment, promoting antigen presentation and T-cell infiltration while overcoming resistance mechanisms that limit immune checkpoint inhibitor monotherapy.

Interstitial PDT treats centrally located lung tumors with or without prior radiotherapy. Our ongoing trial investigates 8 Gy followed by Visudyne-based interstitial PDT for malignant central airway obstruction. PDT demonstrates favorable pulmonary toxicity versus radiotherapy with less immune infiltration and fibrosis. Combined radiotherapy-PDT provides synergistic efficacy through radiation-induced immunogenic cell death followed by PDT-mediated ROS generation and vascular disruption and has potentially unique synergies with immunotherapy.

Emerging Combination Strategies: Integration of photosensitizers with alpha-emitting radiotherapeutics represents a promising frontier. Alpha particles can serve as internal Cerenkov radiation sources activating photosensitizers in deep tumors, eliminating external light delivery. These therapies may synergize with PARP inhibitors or immunotherapies. Self-assembled radiolabeled photosensitizers enable simultaneous radiotherapy and Cerenkov-induced PDT. Recent FLASH-PDT innovations demonstrate that saturating photosensitizer absorption with pulsed lasers enables selective tumor ablation while sparing healthy tissue, allowing order-of-magnitude higher doses. Combining FLASH-PDT with FLASH proton radiotherapy may optimize normal tissue sparing and immunomodulation.

Conclusions: PDT for internal tumors presents formidable challenges but demonstrates remarkable efficacy when appropriately applied. Success requires multidisciplinary collaboration among surgeons, radiation oncologists, medical oncologists, and photodynamic specialists. Optimal outcomes emerge from synergistic combinations with radiotherapy, immunotherapy, and novel targeting strategies. FLASH-PDT enables dramatic dose increases while preserving normal tissue.

Radionuclide-photosensitizer conjugates may eliminate depth penetration constraints. As we refine dosimetry, enhance selectivity, and optimize multimodal combinations, PDT's role in treating previously inaccessible internal malignancies continues to expand.

Acetyl Zingerone: A Multi-Pathway Skin Longevity Molecule Targeting AMPK, Nrf2, and the Matrisome

Ratan K Chaudhuri

Sytheon (now part of Hallstar) and CuralysMD Dermaceuticals

Acetyl Zingerone (AZ) is a photostable small molecule derived from the zingerone scaffold and rationally designed to modulate cellular stress-response and longevity pathways. We present mechanistic, genomic, and clinical evidence demonstrating that AZ activates AMP-activated protein kinase (AMPK), a master regulator of cellular homeostasis, thereby enabling continuous protection, repair, and renewal in skin.

Functionally, AZ acts as a multitarget redox modulator, serving as a physical quencher, selective transition-metal chelator, oxidase inhibitor, and peroxynitrite neutralizer, providing sustained defense with minimal molecular depletion. AZ reduces both immediate and delayed cyclobutane pyrimidine dimer (CPD) formation following UV exposure. Transcriptomic analyses show broad upregulation of core matrisome genes, including collagens, proteoglycans, and ECM glycoproteins, with concomitant downregulation of matrix metalloproteinases and inflammatory pathways such as IL-17A/NF-κB. AZ activated the AMPK–NRF2 axis (93% vs control), producing coordinated cytoprotective responses and significant reversal of senescence-associated phenotypes, including 76% reduction in SA-β-gal, 190% increase in FOXO3 activation, and 20% elevation in NAD^+ levels ($p \leq 0.05$). Notably, independent studies in non-cutaneous tissues similarly report AZ-mediated activation of NRF2 signaling and mitochondrial quality control, supporting a broader role for AZ in cellular homeostasis.

Clinically, topical AZ significantly improved redness, wrinkles, pigmentation, and photoaging parameters while normalizing skin microbiome composition. Collectively, these findings position AZ as a next-generation longevity molecule that coordinates NRF2-mediated cytoprotection with AMPK-driven renewal to address both intrinsic and environmentally induced aging.

Lapatinib enhances 5-aminolevulinic acid by inhibiting both ABCG2 and EGFR signaling

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5-Aminolevulinic acid (ALA) is commonly used for eradicating precancerous and cancerous skin lesions by photodynamic therapy (PDT). It is also an intraoperative fluorescence imaging probe approved for the detection and resection of superficial bladder cancer and high-grade gliomas based on fluorescence emitting from the tumor tissue. As ALA on its own has no fluorescence and photosensitizing activity, clinical applications of ALA as a prodrug for tumor fluorescence imaging and PDT depend on tumor cell metabolism of ALA to protoporphyrin IX (PpIX), the active drug exhibiting red fluorescence and PDT activity upon light activation. PpIX produced intracellularly following the administration of ALA is actively transported out of the cell via the ABCG2 transporter that is often expressed in tumor cells. Inhibition of ABCG2-mediated PpIX efflux has been shown to enhance ALA-PpIX fluorescence and PDT response. Since there are no ABCG2 inhibitors available for clinical application, we have repurposed lapatinib, an approved EGFR and HER2 kinase inhibitor, as an ABCG2 inhibitor for the enhancement of ALA. Here we show that lapatinib significantly enhanced ALA-PpIX fluorescence in tumor cell lines with, but not in tumor cell lines without, ABCG2 activity. More importantly, we found that ALA-PDT activated the phosphorylation of ERK, a downstream molecule of the EGFR signaling pathway. Lapatinib effectively inhibited PDT-induced ERK phosphorylation, enhancing tumor cell apoptosis and growth inhibition when used in combination with ALA-PDT. Our results indicate that lapatinib enhanced ALA by co-targeting both ABCG2 and EGFR signaling pathway.

Glutamatergic signaling in acral/mucosal melanoma

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Most melanomas are classified as cutaneous. Rare melanomas, such as acral and mucosal, are difficult to diagnose mainly due to low incidences and lack of diagnostic markers. Previous research in our lab showed that the ectopic expression of a G-protein-coupled seven-transmembrane-domain-neuronal-receptor, metabotropic glutamate receptor 1 (mGluR1) in melanocytes leads to cell transformation in vitro and malignant tumor formation in vivo, as well as the activation of the MAPK signaling cascades. Recently we initiated studies to examine the involvement of glutamatergic signaling mediated by mGluR1 in acral and/or mucosal melanomas. mGluR1 expression was detected in human acral and mucosal melanoma cell lines, PDXs and human mucosal melanoma tissue microarrays. We assessed the functionalities of mGluR1 in acral/mucosal cells using pharmacological reagents of glutamatergic signaling. We selected two different but complementary inhibitors for the studies, riluzole and Bay 36-7620. Using MTT cell viability/cell proliferation assays, we demonstrated that cultured acral or mucosal melanoma cell lines were sensitive to both riluzole and Bay 36-7620 in a time and dose-dependent manner. These findings showed that mGluR1 in acral/mucosal cell lines are functional. In vivo xenografts treated with riluzole showed minimum responses suggesting the involvement of mGluR1 and/or glutamatergic signaling in the etiology of acral and mucosal melanoma.

Immunosuppression by cyclosporine A accelerates melanoma initiation and progression in BRAFV600E/PTENNull mice

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Solar ultraviolet (UV) radiation induces DNA damage and pro-tumorigenic signaling in melanocytes, processes that are normally mitigated by intact immune surveillance. Cyclosporine A (CsA), a calcineurin inhibitor widely used to prevent transplant rejection, exerts potent immunosuppressive effects that can inadvertently increase melanoma susceptibility. Alarmingly, the risk of death from melanoma is significantly higher in immunosuppressed patients, including organ transplant recipients (OTRs). However, an important gap persists in our understanding of how CsA alters the tumor microenvironment to influence melanomagenesis in these high-risk groups. In this study, we aimed to mimic the immunosuppressed conditions in OTRs by using CsA treatment in BRAFV600E/PTENNull mice and determined the effects of immunosuppression on melanoma development and progression. Mice (n=28; 6-8 females and males/group) orally treated with CsA (10 mg/kg b.wt; 5d/week for 9 weeks starting 2 weeks before melanoma initiation by 4-hydroxytamoxifen), showed early pigment onset and more aggressive tumor progression compared to vehicle treatment. Kaplan-Meier analysis showed that CsA significantly decreased the tumor-free survival of mice. LegendPlex cytokine array analysis of serum samples showed that CsA significantly decreased IL-2 and TNF-α, validating its immunosuppressing effects. To further determine how CsA alters the melanoma immunogenic landscape, we performed spatial transcriptomics of collected tumors (immunostained with S100/PMEL and CD45). We identified multiple differentially modulated cancer- and immune-associated genes/pathways, including mTOR signaling as one of the top upregulated pathways, which suggests that CsA has melanoma-promoting roles beyond its classic T-cell suppression. Overall, our study provides useful novel information regarding the mechanisms of immunosuppression-accelerated melanoma progression.

Tailoring Visible-Light Activated Rhodium(III)-BODIPY Complex for Oxygen-Free Photodynamic Therapy

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Rhodium(III)-boron-dipyrromethene (RhIII-BODIPY) complexes represent a novel class of light-inducible compounds with potential applications in molecular biology and therapeutic development. These complexes integrate the photophysical properties of BODIPY with the DNA-binding capabilities of Rh(III) centers, enabling precise molecular interactions upon visible light activation. This project aims to establish a foundational understanding of RhIII-BODIPY complexes by elucidating their structure-activity relationships (SAR) and functional impact on cellular processes. We hypothesize that structural modifications influence their photophysical properties, allowing for tunable DNA binding and biological activity. We synthesized and characterized RhIII-BODIPY complexes by systematically evaluating how modifications to the diimine ligand affect their photophysical behavior and DNA affinity. Spectroscopic and biochemical assays are performed to determine whether visible light activation enhances selective DNA interactions. The biological function in cultured cells is assessed by measuring cellular uptake, localization, and light-induced effects on cytotoxicity, apoptosis, and proliferation using fluorescence microscopy, MTS assays, Annexin V/PI staining, and BrdU/EdU incorporation are also conducted. The study will not only advance the understanding of light-activated biomolecular interactions but also cultivate the next generation of scientists through immersive, research-intensive education.

Visible light and skin carcinogenesis – What do we know?

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Skin cancer research over the past 50 years has provided a detailed action spectrum for squamous cell carcinomas, but much less information for basal cell and malignant melanoma due primarily to lack of robust testing models. Research done in the 1970s and 1980's on hairless mice focused on the impact of UV-B and UV-A radiation as the causative agent of skin cancers, while limited eTort was made to evaluate the impact of visible light on the skin, particularly induction of skin cancers. Unexplained results from earlier photo-carcinogenesis research suggest there may be some influence of visible light on skin cancer induction. A recent publication claiming evidence of blue light as a causative agent of skin cancer requires careful examination and will be discussed. Evidence of blue light eTects on skin is becoming well documented through reactive oxygen pathways and the Opsin-3 calcium mediated pathway for cutaneous pigmentation. While searches for classic pyrimidine-dimer formation with visible/blue light exposures have been negative, 8-oxoguanine formation has not yet been ruled out as a possible route to visible light induced carcinogenesis. The primary causative agent for solar keratoses and skin cancers is certainly shortwave UVB and to a lesser degree UVA radiation; Convincing evidence that high energy visible light makes a measurable contribution to such neoplasia has yet to be offered.

Risks from ambient light - detection of DNA damage

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Damage to nucleic acids [DNA, RNA the precursor 2'-deoxy(ribo)nucleotide pools] can arise from a variety of exogenous and endogenous sources leading to a broad spectrum of diOerent types of adducts. Such damage is implicated in the cause of a wide variety of diseases although, with some notable exceptions, linking specific types of exposure/damage to corresponding diseases has been challenging because, until recently, it has been impossible to detect the totality of damage to nucleic acids i.e., the nucleic acid adductome.

Exposure to solar ultraviolet radiation (UVR) and visible light have long been associated with the generation of ROS, induction of oxidative stress and formation of oxidatively generated damage to nucleic acids. Given the mutagenic potential of oxidized DNA, and the other potential adducts arising from UVR/visible light, such exposures are clear risk factors for photocarcinogenesis. Indeed, our work has shown that ambient solar UVR exposure of the skin contributes at least 15% to the total whole-body levels of oxidative stress, and this eOect is significantly modulated by the melanin content of the skin.

To better understand the critical adducts, and therefore mechanisms, involved in photocarcinogenesis an untargeted approach is warranted. Using liquid chromatography with high-resolution mass spectrometry, we pioneered the techniques of both cellular and urinary nucleic acid adductomics to comprehensively evaluate the nucleic acid adductome. This approach has revealed over 1,000 diOerent adducts in urine and discovered the existence of new classes of adducts. The strengths of this approach are likely to be invaluable to better understanding the mechanisms underlying environmental origins of disease.

Structure–Function Insights into Amino-Flavylium Dyes for Antimicrobial Photodynamic Therapy

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REQUIMTE/LAQV

Antimicrobial resistance is accelerating worldwide and is expected to cause up to 10 million deaths per year by 2050, emphasizing the urgent need for therapeutic options that move beyond conventional antibiotics. Photodynamic therapy (PDT) has emerged as a promising non-invasive strategy due to its targeted action and compatibility with modern biomedical platforms. In this work, we investigated a new series of amino-substituted flavylium dyes (λ_max 550–650 nm) as candidate photosensitizers for antimicrobial PDT. Modifications at the C7 and C4′ positions of the flavylium core were found to play a central role in tuning light-induced activity. Upon irradiation with a white LED source (~4 J/cm²), these dyes effectively inhibited the growth of Staphylococcus aureus and Pseudomonas aeruginosa, with Gram-positive bacteria showing the strongest response; complete photoinactivation of S. aureus occurred at 3–12 μM. The compounds also exhibited excellent photostability (≥ 90%), even under higher light doses than those required for biological assays. Confocal microscopy confirmed rapid bacterial adsorption and uptake within 30 minutes, and atomic force microscopy revealed membrane disruption accompanied by cytoplasmic leakage. Indirect detection of singlet oxygen supported a reactive oxygen species–driven mechanism underlying their antimicrobial activity. When formulated in a carbomer-based gel, the dyes maintained favorable physicochemical properties and even displayed enhanced absorption and fluorescence. The gels demonstrated remarkable photostability after exposure to 90 J/cm², further supporting amino-functionalized flavylium dyes potential as a promising new platform of photosensitizers for light-based antimicrobial technologies.

Machine Learning Prediction of CDKN2A Germline Status in Melanoma

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Background: Arizona experiences disproportionately high rates of melanoma, driven by intense ultraviolet exposure and a growing, diverse population. Familial melanoma, particularly cases associated with germline CDKN2A mutations, presents unique challenges for early detection and intervention.

Current National Comprehensive Cancer Network (NCCN) guidelines for genetic testing fail to identify a substantial proportion of at-risk individuals, as evidenced by a recent multi-site cohort including Phoenix, Arizona, where 72% of melanoma patients with pathogenic germline variants did not meet existing screening criteria.

Methods: We developed a machine learning (ML) algorithm to predict CDKN2A germline mutation status directly from digital whole-slide images (WSIs) of melanoma biopsies. Our cohort included 40 CDKN2A mutation-positive and 253 germline-negative melanoma cases. Attention-based multiple instance learning models, including both vision-only and vision-language foundation models, were trained and evaluated for predictive performance. Cellular and morphological features were extracted and statistically compared between mutation-positive and negative groups.

Results: The best-performing model achieved an area under the curve (AUC) of 0.72 and a negative predictive value (NPV) of 0.92. Morphological analysis revealed that CDKN2A-positive melanomas exhibited slightly larger, rounder, and brighter neoplastic cells. Texture and boundary features also differed between groups.

Conclusions: Our findings demonstrate that ML-based analysis of digital pathology can accurately infer CDKN2A germline status from melanoma WSIs, offering a scalable approach to augment population-based screening in Arizona and similar high-incidence regions. The integration of AI-driven diagnostics with public health strategies may enable the earlier identification of high-risk individuals, address workforce shortages, and improve melanoma outcomes in the Southwest.

Application of Biocompatible Organic Prodrugs in Phototherapy, Bioimaging, and Cancer Cell Proliferation Inhibition

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Photodynamic therapy (PDT) is a clinically approved, non-invasive cancer treatment that involves administering a photosensitizer and using light to target the affected area. Currently, the range of photodynamic therapy agents is limited, creating a pressing need for cost-effective, organic photosensitizers that can enhance efficacy through multiple photosensitization mechanisms and serve dual purposes for image-guided PDT. In this presentation, I will discuss recent advances made by our group in developing biocompatible organic prodrug as photosensitizers that feature tunable absorption spectra across the visible to near-infrared (IR) regions of the electromagnetic spectrum. These PSs demonstrate substantial PDT efficacy against human epidermoid carcinoma, melanoma, cervical cancer, and human epithelial cancer cells, regardless of oxygenation status (i.e., under both normoxic and hypoxic conditions), when tested in vitro with a low dose of light. Additionally, some of these photosensitizers decrease or stop the proliferation of cancer cells in the absence of light activation or

can be activated by two-photon absorption in the near-IR for PDT and bioimaging applications.

Structure–activity relationships in porphyrinoids for antimicrobial and anticancer photodynamic therapy

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Jagiellonian University

Understanding how structural features translate into biological performance is essential for designing effective photosensitizers (PSs) for antimicrobial photodynamic inactivation (aPDT) and anticancer photodynamic therapy (PDT). Although both approaches rely on the photochemical generation of ROS, the biological landscapes in which they operate differ profoundly. Porphyrinoids are ideal model scaffolds for dissecting these differences because their charge, redox properties, excited-state behaviour, and supramolecular interactions can be adjusted with molecular precision.

In aPDT, the decisive factors include strong binding to microbial surfaces, rapid singlet oxygen generation, and high photostability. Porphyrins and metalloporphyrins bearing positive charge with ammonium or imidazolium substituents show rapid uptake by Gram-positive and Gram-negative bacteria, efficient penetration of biofilms, and robust photokilling even under moderate irradiation. Fluorinated or sulfonamide-modified derivatives further improve solubility and access to dense microbial matrices.

In contrast, anticancer PDT requires deep-tissue activation and effective operation in hypoxic environments. Bacteriochlorins and other NIR-absorbing porphyrinoids (especially bacteriochlorins) provide high triplet yields and enhanced light penetration. Proper substitution, help fine-tune aggregation, triplet lifetimes, and ROS type I/II balance, supporting selective accumulation in tumors and sustained phototoxicity in normoxic and hypoxic regions.

Comparative analysis shows that cationic, photostable derivatives dominate in aPDT, whereas NIR-active, amphiphilic systems are superior in tumor PDT. Yet both applications follow the same core relationships linking electronic structure, redox behavior, and excited-state dynamics with biological outcome. With appropriate structural modulation and formulation, the porphyrinoid macrocycle becomes a universal platform adaptable to both infectious and oncological settings.

Photochemistry and Mechanistic Studies of Diaryl Sulfondiimine Derivatives

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Sulfondiimines are often classified among the sulfur (VI) class of organosulfur compounds, including sulfone and sulfoximines. Sulfondiimines with their unique properties, such as high aqueous solubility, polarity, and chirality, make them significant in medicinal and agrochemical research. In this work, the photochemical behavior of several diaryl sulfondiimine derivatives was investigated to evaluate their ability to generate reactive intermediates (nitrenes). Upon ultraviolet (UV) irradiation, diaryl sulfondiimines have proved to be photoactive and exhibit dual-release photochemistry, in which the weaker S-N bond breaks first, followed by the stronger S-N bond forming aromatic or alkyl nitrenes. Bond Dissociation Energies (BDEs) of the S-N bonds of each sulfondiimine were predicted computationally using m062x functional with the def2-TZVP basis set. The reactive intermediates (nitrenes) were trapped using suitable nucleophiles such as amines and alkenes. Photosensitization experiments were conducted to determine whether azo compounds are photoproducts, assuming that a triplet nitrene was released during photolysis. Additionally, the quantum yield (QY) of each sulfondiimine was quantified using actinometry at low conversion conditions. Disubstituted sulfondiimines (N-aryl, N-aryl-alkyl) exhibited higher QY values than monosubstituted analogues (N-aryl or aryl–alkyl, N-H). Time-dependent photo-irradiation studies further established photodegradation profiles and intermediate formation for each sulfondiimine, contributing to the prediction of the mechanism of each sulfondiimine photolysis.

Investigating the solvent specific spectral responses of carotenoids through resonance Raman spectroscopy

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Carotenoids play significant role in plant responses against various stress conditions. Carotenoids are known to be sensitive to subtle alterations in their surrounding microenvironment. Extraction of such microenvironment specific spectral responses of carotenoids would translate to assessment of various stress conditions. Therefore, we present a study that investigates carotenoid response in polar and non-polar solvents using resonance Raman spectroscopy. The polar and non-polar solvents are used to model different microenvironments surrounding carotenoids. Since subtle microenvironment specific spectral responses of carotenoids are hard to extract, we employed polynomial baseline correction and normalization to the raw Raman spectra. This specific preprocessing method focuses on minimizing intensity variation of carotenoid bands while emphasizing the possible minute shift due to change in solvents. In this study, we measured β-carotene in several non-polar and polar solvents using green excitation to induce the resonance effect. Oleic acid and linoleic acid were chosen to represent the non-polar solvents while dimethyl sulfoxide, ethyl acetate and toluene were chosen to represent polar solvents. When we compared the carotenoid bands in non-polar and polar solvents, we found that there were some solvent specific subtle spectral shifts. These shifts were less than 3 cm-1, yet they produce prominent spectral signatures. Overall, our study shows how solvent specific subtle carotenoid responses can be obtained using resonance Raman spectroscopy.

Lanthanide-based complexes for bioimaging and singlet oxygen generation

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Lanthanide ions display characteristic light emission, based on transitions within the 4f orbitals, which is most efficiently sensitized through coordinated ligands, a process known as the antenna effect. These organic ligands can be further tailored to display interesting properties, such as the ability to generate cytotoxic singlet oxygen. Thus, one can envision using lanthanide complexes for bioimaging through their light emission and for therapy through their cytotoxicity.

Here, we will discuss several such lanthanide complexes isolated by our group. Our strategy involved combining known chelators and sensitizers of lanthanide ion emission, such as pyridine-bis(carboxylate) and pyridine-bis(carboxamide), and substituting them at the para position of the pyridine ring with functional groups capable of generating 1O2, namely oligothiophenes, and naphthalimide. Several complexes of the isolated complexes displayed the dual properties, with efficiencies of luminescence and 1O2 generation that compare favorably with known emitters and photosensitizers. The complexes with ligands containing the naphthalimide functional group showed excellent solubility in organic solvents, characteristic lanthanide ion emission in the visible and NIR, concurrently with efficient 1O2 generation. The lack of aqueous solubility prevented their use in biological applications, but we were able

to demonstrate the ability to degrade a pollutant of emerging concern in aqueous samples, when generating 1O2 with the compounds embedded in a polymer. The complexes with ligands containing the oligothiophene-based functional groups showed biocompatibility and significant photocytotoxicity, with low dark toxicity, while also enabling bioimaging through the metal-centered emission.

Multi-scale mechanisms of light adaptation in green sulfur bacterium Chlorobaculum tepidum

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Green sulfur bacteria (GSB), such as Chlorobaculum tepidum, are anaerobic phototrophs that thrive in extremely low-light environments by coupling photosynthesis to the oxidation of reduced sulfur compounds. Despite their ecological importance, the molecular and cellular mechanisms underlying GSB adaptation to changing light conditions remain poorly understood. Here, we investigated the effects of light intensity on C. tepidum using an integrated approach combining optical spectroscopy, RNA sequencing, quantitative mass spectrometry–based proteomics, and electron microscopy (EM).

Cells were grown under low, medium, and high light conditions to probe regulatory responses across molecular and cellular scales. Optical spectroscopy revealed systematic shifts in bacteriochlorophyll absorption profiles, consistent with light-dependent remodeling of the photosynthetic apparatus.

Transcriptomic analysis identified differential regulation of genes involved in photosynthesis, sulfur metabolism, and stress response pathways. Proteomic measurements revealed both concordant and discordant trends relative to RNA expression, suggesting substantial post-transcriptional regulation across light conditions. EM imaging further demonstrated pronounced morphological differences as a function of light intensity.

Together, these results provide a multi-scale view of how C. tepidum dynamically adapts to changes in light availability, linking gene regulation and protein expression to structural reorganization. This work advances our understanding of photosynthetic adaptation in low-light environments and highlights the value of integrating multi-omics with imaging approaches to study microbial photophysiology.

Investigating Novel Targets for Topical Immunoprevention of Keratinocytic Skin Cancer in Arizona Through the Cancer Immunoprevention Network (CIP-Net)

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Non-melanoma skin cancer (NMSC) represents a major public health burden of special interest in Arizona. Cutaneous exposure to solar ultraviolet (sUV) radiation is a causative factor in NMSC, and inflammatory dysregulation is a key mechanism underlying UV-driven skin damage. The identification of targetable immune checkpoints such as PD1/PD-L1 is improving clinical cancer outcomes. However, leveraging immune checkpoint modulation for cancer prevention remains underdeveloped. We recently showed that PD-L1 is upregulated in epidermal keratinocytes after acute and chronic UV stimulation in human skin and may serve as a target for skin cancer immunoprevention. Notably, the possibility that other stress-induced immune checkpoint proteins are also upregulated by UV exposure and represent immunoprevention targets of NMSC has not been explored. We recently initiated a study under the Cancer Immunoprevention Network (CIPNet) UG3/UH3 mechanism to test the hypothesis that overexpression of select UV-responsive immune checkpoint proteins early in progression from normal skin to NMSC promotes an immune-suppressive microenvironment and can be targeted to prevent photocarcinogenesis. In the UG3 phase, we are collecting matched human samples of sun-protected skin, sun-damaged skin, actinic keratoses, cutaneous squamous cell carcinomas (cSCC; 30 sets), and basal cell carcinomas (BCC; 30). These samples are being used for bulk RNAseq and immunohistochemistry to identify novel immune checkpoint proteins upregulated early in skin carcinogenesis. The UH3 phase will confirm that the targets behave similarly in mouse skin, influence keratinocyte responses to UV stress, and modulate cutaneous UV responses in a transgenic mouse model. The ultimate goal is to identify molecular immune biomarkers enabling earlier intervention to reduce cSCC morbidity and mortality.

Identifying novel biomarkers for effective prevention of skin carcinogenesis

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Ultraviolet (UV) radiation causes DNA damage and immune suppression that lead to skin carcinogenesis. We demonstrated that the vitamin D hormone, 1,25-dihydroxyvitamin D (1,25D), and vitamin D-like compounds including 1,25-dihydroxylumisterol and tetrahydrocurcumin, applied immediately after UV, reduce DNA damage, immune suppression, and skin tumour development. Although several photoprotective candidates attenuate UV-induced DNA damage and immune suppression in acute studies, some fail to reduce photocarcinogenesis in a 40-week murine model. This highlights the need for reliable, easily measurable biomarkers, beyond DNA damage and immune suppression, to predict which agents reduce skin tumours in chronic models. We investigated the photoprotective properties of vitamin D compounds in primary human skin cells, Skh:hr1 mice, and ex vivo human skin, to establish a framework for identifying predictive biomarkers. PTEN (phosphatase and tensin homolog) and NDRG1 (N-myc downstream regulated gene-1), proteins commonly lost during carcinogenesis and metastasis, were significantly reduced 24 h after UV exposure, but restored with 1,25D treatment. Phosphorylated CREB (cyclic AMP response element binding protein), a transcription factor linked to carcinogenic potential, increased following UV and was modulated by vitamin D compounds. Interleukin-6 (IL-6), an inflammatory marker, and IL-10, which contributes to immune suppression, were both increased after UV, but this was reversed by 1,25D. Evaluating photoprotective agents in preventing UV-induced skin tumours is crucial for developing more effective bioactive alternatives to conventional sunscreens.

This process, however, is lengthy and resource intensive. Uncovering early biomarkers that predict efficacy and eliminate ineffective agents would significantly expedite the identification of promising photoprotective agents.

Role of Bacterial Heterogeneity in Modulating ROS-Mediated Antimicrobial Phototherapy

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Pathogen survival under various treatments is often influenced by the ability of cells to withstand oxidative stress. This type of stress arises when the balance between reactive oxygen species (ROS) and antioxidant defenses is disrupted, resulting in cellular damage. ROS are highly reactive molecules that can damage lipids, proteins, and nucleic acids, ultimately compromising cell function and integrity. While ROS are typically produced as byproducts of cellular metabolism, they can also be deliberately generated to target and eliminate pathogens. In particular, photosensitizers (PS), molecules that absorb light and generate ROS, can be used to selectively induce oxidative damage in microbial cells, offering a promising strategy for antimicrobial treatments.

In this study, we use fluorescence microscopy combined with cell viability markers to assess Escherichia coli phenotypic survival dynamics under varying oxidative stress conditions. Experiments were conducted under nutrient-rich (LB broth) and nutrient-deprived (PBS) conditions to evaluate the influence of metabolic state. Our findings indicate significant heterogeneity in ROS susceptibility: while some cells are rapidly inactivated, others continue to divide despite ongoing oxidative stress. These results highlight the importance of phenotypic diversity in bacterial stress responses.

Monte Carlo Radia.ve Transfer: A Two-Decade Astrophysical-Clinical Partnership in Photomedicine

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For two decades a research collaboration between the University of St Andrews' astronomy department and the Photobiology Unit (PBU) at Ninewells Hospital in Dundee, Scotland, has leveraged computational physics to advance photomedicine. This partnership utilised Monte Carlo Radiative Transfer (MCRT) code, originally designed for simulating complex astrophysical radiation transport (e.g., through galactic dust and gas), and adapted it to accurately model light propagation through turbid biological tissues. The methodology has since been applied extensively to model light interaction within skin, non-melanoma skin cancers (NMSC), and brain matter.

Initial PDT simulations demonstrated that administering adequate light doses in PDT, even after surface Protoporphyrin IX (PpIX) fluorescence diminishes, is essential to ensure therapeutic efficacy at depth, a principle subsequently proven clinically. MCRT models were also instrumental in exploring the feasibility of daylight-activated PDT in Scotland, a modality that is now routinely offered and frequently preferred by patients in clinical services.

Further impacts include quantifying the carcinogenic risk associated with artificial tanning units by modelling UV photon transport and resultant direct DNA damage in the basal layer of skin. Research also demonstrated that erythema observed from Far-UVC was caused by longer wavelengths from unfiltered Krypton-Chloride lamps. Most recently, MCRT was employed to simulate intraoperative PDT for glioblastoma, incorporating algorithms for light fluence, photosensitiser, and oxygen depletion. The cumulative findings supporting depth dosimetry resulted in the publication Depth Penetration of Light into Skin as a Function of Wavelength from 200 to 1000 nm, which is being awarded the 2026 ASP Photocite A Award.

Photodermatoses: the role of light in diagnosis

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The Scottish Photobiology Service (SPS) is a tertiary healthcare service for the diagnosis and management of photodermatoses (light sensitivity) in Scotland. Through investigation, research and collaboration we aim to create technologies and discoveries that help improve the quality of life of our patients.

Most patients (87%) undergo irradiation monochromator phototesting, where narrowbands of ultraviolet and visible light are shone onto the individual's skin and the skin reaction is compared to a non-photosensitive population reference, where the lowest Minimal Erythema Dose (MED) is 0.76 Standard Erythema Dose (SED).

Of individuals investigated at the SPS, 64% were diagnosed with a photodermatosis, of which 75% had sensitivity to monochromator phototesting. Polymorphic Light Eruption (PLE) was the most common diagnosis (40%), although only 51% were monochromator sensitive. Chronic Actinic Dermatitis (CAD) accounted for 31% of diagnoses, with 100% being monochromator sensitive. All CAD patients were ultraviolet-B (UVB) sensitive and, in a sub-analysis, narrowband (NB) UVB was found to be a potentially useful screening tool (sensitivity 84%, specificity 79%), which is available in secondary healthcare.

Clothing is the primary photoprotective measure for those with photodermatoses, and in an analysis of high-street products, we found 70% to have an ultraviolet-protection factor (UPF) >40. In general, dark, tightly woven synthetic products had the highest protection factors and price was not found to correlate with photoprotection. The current sunscreen trend for longer wavelength ultraviolet-A (UVA) and visible light protection is proving beneficial to the photosensitive population, who often have heightened sensitivity to UVB, UVA and visible light.

Interstitial Chemo-Phototherapy for Ablating Locally Advanced Cancers

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Chemo-Phototherapy (CPT) involves the administration of a photosensitive particle loaded with a chemotherapy drug that upon light activation releases its contents into the irradiated tumor volume creating a localized chemotherapeutic response and reducing systemic toxicity. Interstitial CPT (I-CPT) involves interstitial laser

light administration for the treatment of locally advanced cancers that failed or are not eligible for current standard of care therapies. We have developed a novel I-CPT that utilizes image-based planning and on-line light dosimetry for guiding interstitial 665-nm laser light delivery to activate a porphyrin-phospholipid liposomal formulation of doxorubicin (PhotoDOX). In this study, we demonstrated that a light dose of 25 J/cm2 is required to induce blood vessel permeability and controlled release of PhotoDOX within the tumor microenvironment, while a light dose of 50 J/cm2 is suboptimal due to increased vascular shutdown. We applied our translational image-based computer simulations of interstitial light delivery to develop treatments plans to administer 25 J/cm2 at the tumor margins during I-CPT with PhotoDOX in the treatment of locally advanced triple negative breast cancer (TNBC) in mice, as well as in large, locally advanced hepatocellular carcinoma (HCC) in rats and woodchucks. Tumor regression and cures were observed following I-CPT with PhotoDOX and 25 J/cm2. In the woodchucks with HCC, normal liver tissue regeneration was observed post I-CPT. This study demonstrated that image-based I-CPT with PhotoDOX is a safe, selective, and potentially effective ablation modality for the treatment of large, locally advanced HCC and TNBC.

Cholesterol-Dependent Regulation of PHB-1 Nuclear Function and Self-Aggregation Following Solar UV Irradiation in Keratinocytes

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Prohibitin-1 (PHB-1) is a multifunctional scaffold protein involved in mitochondrial stability, transcriptional regulation, and cellular stress responses. Although its nuclear localization has been observed under stress, the upstream regulators of this process remain unclear. Cholesterol, a key organizer of membrane signaling domains, may influence nuclear stress pathways. In this study, we examined whether cholesterol availability modulates PHB-1 nuclear translocation, oligomerization, and interaction with the transcription factor E2F1 following solar-simulated ultraviolet (sUV) irradiation in HaCaT keratinocytes. Cells were exposed to sUV with or without cholesterol depletion using methyl-β-cyclodextrin (MβCD). Subcellular fractionation, immunofluorescence, immunoprecipitation, and proximity ligation assays were used to assess PHB-1 localization and interaction dynamics. PHB-1 exhibited rapid nuclear accumulation within 1-2 hours post-sUV, confirmed by both biochemical fractionation and imaging. Immunoprecipitation revealed increased PHB-1 self-oligomerization at 1 hour, while proximity ligation assays demonstrated enhanced PHB-1/E2F1 interactions that peaked at 2 hours and declined by 6 hours post-sUV. Cholesterol depletion attenuated these responses, reducing PHB-1 nuclear translocation, oligomerization, and E2F1 association. A similar oligomerization response was observed in mouse embryonic fibroblasts, suggesting a conserved mechanism. Taken together, these findings support a role for cholesterol availability in modulating PHB-1 nuclear function during UV-induced stress and suggest a potential link between membrane organization and nuclear transcriptional responses in keratinocytes. This research was partially supported by NIH/NIEHS R01-ES030425 (to S. Wu) and a start-up fund from Edison Biotechnology Institute, Ohio University (to V. Bahamondes Lorca).

Multiscale Modelling of Emergent Photoactivated Anticancer Therapies

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Light exploitation as a source of selectivity in anticancer therapies is gaining interest in the last years. The use of biocompatible wavelengths requires the administration of photoactive chromophores that must be distributed into cancerous cells in sufficient concentration to trigger clinically relevant photodamage upon irradiation of the ill area. Therefore, efficient photophysical and photochemical processes are a prerequisite for new photosensitizers to be candidates for clinical development. Traditionally, light-induced biological damage is exerted through the classical O2 mediated type I and/or type II photodynamic therapy (PDT) photoreactions. However, the physiological conditions of solid tumors often imply low levels of molecular dioxygen, limiting the outcome of the already clinically approved drugs.

The present contribution will describe recent approaches to circumvent the hypoxia problem from a multidisciplinary perspective, emphasizing however the contributions of computational chemistry and the use of multiscale methods to elucidate the molecular and electronic mechanisms behind the photodamage. The photoprocesses that will be considered are mediated by novel organic molecules and organometallic complexes.

Circadian Rhythm Disruption Amplifies Arsenic and UVB Co-Carcinogenicity in Skin by Altering the Methylation and Transcriptomic Landscape

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Abstract: Inorganic arsenic (As) is a widespread environmental carcinogen, yet it shows limited tumorigenicity in experimental skin models. However, co-exposure with ultraviolet B radiation (UVB) markedly enhances As-induced cutaneous squamous cell carcinoma (cSCC).

Environmental circadian disruption (ECD), a common but understudied exposure, may further potentiate arsenic's effects by impairing DNA repair and altering gene regulation. We investigated whether ECD amplifies the skin carcinogenic synergy between As and UVB via epigenetic and transcriptional dysregulation. We hypothesize that ECD amplifies the effects of As and UVB by altering DNA methylation and gene expression, thereby increasing skin cancer susceptibility. We profiled the epidermal methylome and transcriptome using a SKH-1 hairless outbred mouse model subjected to chronic ECD, As, and UVB, alone and in combination, using Illumina's Infinium Mouse Methylation Array and bulk RNA sequencing. Although ECD alone induced minimal epigenetic and transcriptional changes, its combination with As or UVB significantly elevated the number of differentially methylated regions (DMRs) and differentially expressed genes (DEGs). In particular, the triple exposure group (ECD+ As+ UVB) exhibited the most overlapping DMRs and DEGs, with nearly 50% demonstrating inverse methylation-expression relationships, suggesting epigenetic regulation of gene expression. ECD accelerates the onset of AS- and UVB-induced skin cancer in mice, reducing tumor latency by approximately 4 weeks, an interval equivalent to 8–10 human years. The findings highlight the synergistic impact of ECD with As and UVB on DNA methylation and gene dysregulation, offering new mechanistic insights into environmentally induced skin cancers.

Melatonin chemiexcitation: implications for mechanisms in the progression of macular degeneration

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Accumulation of the autofluorescent pigment, lipofuscin, in the retinal pigment epithelium (RPE) is a hallmark of age-related macular degeneration (AMD) and the inherited retinal disorder, Stargardt's disease. The increase in lipofuscin content in RPE cells with age is strongly correlated with the progression of AMD and numerous studies indicate this results from lipofuscin mediated mechanical, oxidative and photooxidative stress. Recently, the removal of lipofuscin in the presence of melanin in a Stargardt's mouse model has been reported and attributed to a chemiexcitation process. Melanin-like melatonin and serotonin, neurotransmitters playing key protective roles in retinal pathophysiology, are known to undergo chemiexcitation when oxidized by horseradish peroxidase/H2O2. Using LCMS and HRMS, we observe the dicarbonyl oxidation products formed from the 1,2-dioxetane precursor. The dicarbonyl products are formed initially in a triplet excited state because of the exothermicity of the dioxetane cleavage. The melatonin dioxetane half life is measured as 150 s with an activation energy of 113 kJ/mol for the unimolecular decomposition; in comparison, the EA for tetramethyl-1,2-dioxetane has been reported by several groups to be in the range 110 – 117 kJ/mol. We have not been able to reliably measure t1/2 and EA for the serotonin system because the decomposition occurs much more rapidly. In order to better understand these di_erences in reaction timeframes, we will report results of computational studies of these processes using several di_erent levels of theory (CBS-QB3, tdDFT and molecular dynamics). Involvement of singlet oxygen in a proposed chain mechanism will also be discussed.

Synthesis and characterization of homoleptic oligothienyl-substituted Ir(III) and Ru(II) bis(terpyridine) complexes: photophysics and photodynamic therapeutic effects

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Photodynamic therapy (PDT) is a promising cancer treatment that offers high selectivity and low systemic toxicity but is limited by tumor hypoxia and the weak red to near-infrared absorption of many photosensitizers. Transition metal complexes provide a versatile platform to address these challenges due to their tunable excited-state properties, strong absorption, and favorable solubility. Building on prior studies of heteroleptic Ir(III), Ru(II), and Os(II) bis-terpyridine (tpy) complexes with oligothienyl substituents, we synthesized four homoleptic Ir(III) and Ru(II) complexes, Ir/Ru(nT-tpy)$_2$ (n=3-4), featuring symmetric oligothienyl substitution. Photophysical characterization revealed bathochromic shifts and enhanced molar extinction coefficients relative to heteroleptic analogs, arising from extended π-conjugation. However, the homoleptic series exhibits shortened triplet lifetimes due to increased $3\pi\pi^*$/3ILCT contributions and accelerated nonradiative decay at lower T_1 energies. Although all complexes are weak emitters and unsuitable for imaging, they efficiently generate singlet oxygen, supporting their potential for PDT, with Ru complexes showing slightly enhanced $^1O_2$ generation. In vitro PDT studies against SKMEL28 melanoma cells under normoxic (~18.5% O_2) and hypoxic (~1% O_2) conditions, using broadband visible, green (523 nm), and red (633 nm) irradiation, showed low dark cytotoxicity but strong photocytotoxicity. Ir(III) homoleptic complexes outperformed their heteroleptic counterparts under normoxia, while Ru(II) heteroleptic complexes were more effective than the homoleptic series. Notably, Ir(4T-tpy)$_2$ retained PDT efficacy under hypoxia, highlighting the benefit of symmetric oligothienyl substitution. Additionally, all complexes exhibit exceptional light-activated antimicrobial activity against S. aureus at nanomolar concentrations, outperforming many established photosensitizers.

Programmable Photo-Active CPC-like Surfactants as Environmentally Benign Alternatives to Cationic Antimicrobial Agents

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Quaternary ammonium compounds (QACs), especially cetylpyridinium chloride (CPC), are prominent antimicrobial agents used in personal care, hygiene, and pharmaceutical products. However, the extensive use of CPC has led to its development of antimicrobial resistance, while its robust chemical stability contributes to environmental contamination through accumulation. Therefore, designing less persistent and biodegradable QACs that incorporate natural product scaffolds while maintaining their effectiveness against microbes is of great interest. Herein, our lab has designed and prepared novel photo-active CPC-like platforms that exhibit superior antimicrobial performance at concentrations far below the current concentration ranges where most QACs are effective. Bioassay investigations against both Gram-positive and Gram-negative bacterial strains, such as S. mutans, S. aureus, P. aeruginosa, K. pneumoniae,

E. Coli, etc., generated MIC values significantly higher than those for currently used QACs. Additionally, the critical micellar concentration (CMC) values of the new CPC-like surfactants are about one order of magnitude lower than those of CPC.

My presentation will detail the synthesis, characterization, and micellization properties of the new CPC-like surfactants. I will also detail their photophysical behaviors, including the generation of reactive oxygen species (ROS). Finally, the presentation will demonstrate the on-demand photochemical degradability of these surfactants, as well as the release of bioactive and volatile agents (aroma and bioactive molecules) during this process.

Harmonize, Align, Educate: the approach of PanEuCOPT COST Action (CA24127) to promote and consolidate photodynamic inactivation of microorganisms within the One Health framework

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The efficiency of photodynamic cell inactivation as an antimicrobial approach is nowadays well established and its alignment with the One Health framework makes it a high potential technology.

The photosensitised production of reactive oxygen species proved able to kill microorganisms with an exceptionally broad spectrum of action and irrespective of the resistance to conventional antimicrobial agents. Despite the extensive body of data demonstrating the efficacy of this approach, the use of inconsistent terminology and heterogeneous experimental

protocols, together with insufficient training/awareness among practitioners in human and veterinary medicine, as well as crop and environmental protection, hindered its implementation outside controlled laboratory environment.

The COST Action CA24127 Pan-European Commission on Photoantimicrobial Testing (PanEuCOPT) brings together more than 150 experts from 28 countries with the goal to promote and accelerate the translation of photodynamic inactivation of microbes to practical applications. Through five working groups, PanEuCOPT will focus on the standardisation of terminology (WG1), advance education and training initiatives (WG2), develop guidelines for robust and comparable testing methods (WG3), and harmonise illumination parameters (WG4); these activities will be interwoven by a coordinated strategy for dissemination and outreach activities (WG5). PanEuCOPT is open to researchers, clinicians, and industry professionals from COST and cooperating countries and actively invites new members to join the initiative.

This presentation will present the COST Action, its structure and its progress to date, and it will outline opportunities for active involvement in the network.

Platinum(II) porphyrin metal-organic frameworks: luminescent tools for optical oxygen sensing in biomineralisation-capable bacteria biofilms

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The ability to repair cracks on concrete surfaces plays a vital role in extending the longevity of concrete structures, reducing the maintenance costs and carbon footprint of built environment.

Recently, biomineralization-based techniques attracted interests as a Nature-inspired solution to generate self-healing building materials. Biomineralization relies on the ability of bacterial to deposit calcium carbonate and seal microcracks on concrete surfaces. This phenomenon, called microbially-induced calcite precipitation (MICP), has been shown to prevent the expansion of the crack, thereby delaying the degradation that leads to structure failure. Progress of biomineralization-based technology depends on the availability of analytical tools to monitor the viability of MICP-capable bacteria expeditiously and in real time.

In this work, we report new optical oxygen sensing agents based on metalloporphyrin-containing metal-organic frameworks (MOFs) to monitor the levels of oxygen in Shewanella oneidensis biofilms.

Four oxygen sensing porphyrins were obtained from the platinum complex of tetrakis-5,10,15,20-pentafluorphenylporphyrin by thiol-fluoride or oxygen-fluoride aromatic nucleophilic displacement. The resulting species were incorporated into MOFs structures, as the sole ligand or in conjunction to 1,4-benzenedicarboxylic acid to generate doped species. We will discuss the oxygen sensing potential of these species in solution and as tools to monitor oxygen consumption in MICP-capable bacteria colonies.

Selective targeting of proteins and pathways using photopharmacology

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North Carolina State University

Phototherapy approaches include photodynamic therapy (PDT), which utilizes chemically stable photocatalysts to sensitize the conversion of endogenous molecules such as oxygen to form transient reactive species (ROS/RNS), and photopharmacology, a complementary approach that relies on molecules that undergo self-modifying photochemistry, such as bond cleavage reactions for the delivery of biologically active products. Ru(II) polypyridyl systems have demonstrated utility for both approaches, and Ru(II) PDT is now well validated, with exceptional patient outcomes from the use of TLD-1433.

Photopharmacology approaches are at an earlier stage of development, but have the potential to achieve selective control over the activity of specific enzymes and cellular signaling pathways. We have developed Ru(II) photocages to deliver small molecules ranging from enzyme inhibitors to Proteolysis Targeting Chimeras (PROTACs). Our current focus is on photocontrol over transcription factors and immunomodulators to impact key pathways in cancer progression and immune regulation. A second focus is on copper homeostasis, as dysregulation of copper is associated with neurological disorders, malignant progression, and immune response. We have created new agents that put both chemical and biological regulation of copper traWicking and sequestration under the control of light. These strategies take advantage of intrinsic biological amplification processes, and may synergize with other treatment approaches, including PDT. The new molecular probes and potential therapeutics are expected to generate novel insights into cellular signaling processes, including fast studies of dynamic events, and to provide a path towards the controlled regulation of immune response.

Light-activated MDM2 inhibitors: Toward spatiotemporal control in cancer therapy

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Tumoral cases among the population have been steadily increasing, and the treatment of cancer remains a major challenge. Due to the large number of chemotherapeutic agents employed and the frequent occurrence of relapses, patient life expectancy is often severely compromised.

Targeting protein–protein interactions (PPIs) with high spatiotemporal precision remains a central challenge in drug discovery and chemical biology. The oncoprotein MDM2, a key negative regulator of the tumor suppressor p53, represents a particularly compelling target due to its pivotal role in cancer progression and its structurally well-defined binding pocket. Although conventional MDM2 inhibitors designed to restore p53 activity have shown considerable promise, their clinical translation is limited by systemic toxicity arising from p53 activation in healthy tissues.

To address this limitation, we investigate light-activated pharmacological strategies—such as the incorporation of photoswitchable groups to achieve precise spatiotemporal control over the MDM2–p53 interaction. In this approach, the inhibitors remain biologically inactive in the dark and are converted into their active anticancer form only upon irradiation with visible light. To enhance clinical applicability, we have designed and synthesized a series of novel compounds that are responsive to green light, allowing for deeper tissue penetration and reduced phototoxicity.

We will present our most recent findings on the visible-light-controlled inhibition of the MDM2–p53 interaction by small molecules, including results from comprehensive biological evaluations demonstrating their activity in relevant cellular models.

Schematic overview of reversible, light-triggered blockade of the MDM2–p53 protein–protein interaction using a photoswitchable inhibitor.

Photochemistry and Photobiology Editor's Lecture

Alexander Greer

Brooklyn College, The Graduate Center of the City University of New York

I am pleased to present an Editor's Lecture for Photochemistry and Photobiology. I am grateful to Lisa Whittingstall for her efforts as Managing Editor, as well as members of the Editorial Board. The lecture will outline the current performance and strategic direction of the Journal. Success continues to be defined by a thriving journal that provides broad, high-quality coverage of the field and serves as a leading hub for photobiology and photoscience, supported by a global authorship and readership. The lecture will present recent data on manuscript submission trends, impact factor, usage and citation metrics, full-text article views, and research exchange platform performance. Full-text views now exceed 500,000 per year, reflecting sustained engagement and strong interest in the articles published in the Journal. The importance of publishing high quality, impactful papers to maintain the Journal's attractiveness and influence will be emphasized. In particular, data indicate that invited contributions, especially Invited Reviews and Special Issues Articles, achieve higher citation impact than regular submissions. Manuscript submissions are especially encouraged from Council members and ASP members, and suggestions of timely and impactful topics for future Special Issues are welcomed.

A photochemist's perspective: From fundamental to translational science to help in photodynamic, antimicrobial, and wound care challenges

Alexander Greer

Brooklyn College, The Graduate Center of the City University of New York

I am honored to receive the 2026 Photon Award and deliver a lecture. Being a part of ASP has been a highlight of my career. It gave me an opportunity to be a part of a great community. I became a member of ASP in 1996 as a graduate student; I then served on ASP Council and Executive Council, and as ASP President, and now serve in the role of EIC for Photochemistry and Photobiology. My research interests have been in organic chemistry and photochemistry to assess mechanistic underpinnings and fundamental problems. This includes interests in light-initiated, and latent dark effects and unraveling mechanistic details that occur post-illumination, as well as compound adjuvanticity and photo-priming for improved cell eradication, bacterial disinfection, and wound care. My interests in photobiology and photomedicine have grown over time with collaborations with Theresa Busch and Timothy Zhu in the Department of Radiation Oncology at the University of Pennsylvania, where we developed mini-probe and handheld PDT devices. I co-founded a company with Alan Lyons for a superhydrophobic antimicrobial PDT bandage system. Here, the sensitizer is not delivered to tissue but instead stays attached to the bandage and singlet oxygen itself is delivered as a gaseous species. With Tayyaba Hasan at the Wellman Center for Photomedicine, Harvard Medical School, we are studying this as a non-antibiotic strategy, which is promising thus far in a mouse burn model. Today, I aim to contribute a photochemist's perspective, based on fundamental and translational science to study photochemistry and photobiology.

DNA Photoproduct Formation at Threshold Doses for Acute Skin Reactions Across the 200-270 nm UVC Spectrum in SKH-1 Mouse Skin

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We previously established threshold doses for acute skin reactions induced by UVC wavelengths ranging from 200 to 270 nm and identified a sharp wavelength-dependent increase in the response. Acute skin reactions progressively declined at shorter wavelengths, leading to a sharp increase in the dose needed to induce a reaction starting at 240 nm and intensifying at lower wavelengths. This trend indicates that far-UVC wavelengths are substantially less efficient at eliciting acute skin responses than longer UVC wavelengths. Notably, a dose of 1162 mJ/cm2 at 222nm was predicted to be needed to induce an acute response within 72h of exposure, more than double the current exposure limit of 480 mJ/cm2.

In this study, we evaluated whether DNA photodamage profiles mirror these wavelength-dependent thresholds. Using ELISA and immunohistochemistry approaches, we quantified cyclobutane pyrimidine dimers (CPDs) and pyrimidine (6-4) pyrimidone photoproducts (6-4PPs) in the epidermis of SKH-1 mice 72 hours after exposure to the predicted threshold dose for each wavelength. For wavelengths below 220 nm, where model-derived thresholds exceed the experimentally delivered doses, we analyzed skin from mice receiving the highest available dose.

By characterizing DNA photodamage under these wavelength-specific threshold conditions, this study provides additional molecular insight into how acute UVC exposures translate into biological responses. These analyses offer mechanistic foundation for interpreting UVC action spectra and contribute critical data towards refining wavelength-specific health risk assessments and informing the development of safe exposure limits for far-UVC technologies.

Longer-Wavelength Emissions from LP-Hg Lamps Influence Depth- and Lesion-Specific DNA Damage in Mouse Skin

Natalia E. Gutierrez-Bayona, Zheng Tang, Manuela Buonanno, David Welch

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Low-pressure mercury (LP-Hg) lamps are widely used for germicidal applications and as positive controls in ultraviolet (UV) safety studies and are often treated as strictly monochromatic 254 nm sources. In reality, these lamps emit additional UVB and UVA wavelengths whose contribution to DNA photodamage in skin remains poorly defined. In this study, we evaluated cyclobutane pyrimidine dimers (CPDs), pyrimidine (6-4) pyrimidone photoproducts (6-4PPs), and Dewar photoproducts in the epidermis and dermis of hairless SKH-1 mice following acute exposures to either filtered (254 nm only) or unfiltered LP-Hg lamp emissions.

Immunohistochemical and ELISA analyses revealed that the influence of longer-wavelength emissions is strongly dependent on both lesion type and tissue depth. While CPD formation in the epidermis of was largely driven by 254 nm radiation, the presence of additional UVB/UVA emissions significantly increased CPD levels in the dermis and enhanced 6-4PPs and Dewar photoproduct formation in the epidermal and dermal layers of mouse skin. These effects were more pronounced at higher exposure doses, indicating that even low-intensity longer-wavelength emissions can meaningfully alter the depth and molecular distribution of UV-induced DNA damage. Consequently, the spectral output of LP-Hg lamps must be carefully considered when modeling UVC-induced damage or using these sources as positive controls in far-UVC safety studies, especially when specific DNA damage endpoints or depth-dependent effects are under evaluation.

Loss of CCAAT enhancer binding protein beta transcription factor primes the keratinocyte cGAS-STING response to UVB-induced DNA damage

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The epidermis serves as the primary defense against many environmental stressors and can sense infection or environmental insults such as ultraviolet radiation. Upon sensing stress, epidermal keratinocytes can initiate a type I interferon (IFN-I) response leading to the up-regulation of IFN-stimulated genes (ISGs). This stimulation of the IFN-I response is widely recognized for its critical role in protecting against infection. Recent studies suggest this same IFN-I response also mediates diverse cellular responses such as proliferation, apoptosis, and the DNA damage response. We have identified the transcription factor CCAAT/enhancer-binding protein-β (C/EBPβ) as a novel regulator of the keratinocyte IFN-I response activated by UVB-induced DNA damage. C/EBPβ knockout primary mouse keratinocytes display an enhanced IFN-I response and increased cell death when exposed to UVB light. The conditional deletion of C/EBPβ in mouse epidermis results in increased expression of IFNβ and numerous ISGs including cytosolic pattern recognition receptors, antiviral proteins, regulators of IFN signaling, and pro-apoptotic genes. We are focused on understanding how UVB DNA damage is activating the IFN-I response in C/EBPβ-deficient keratinocytes. We demonstrate that C/EBPβ-deficient keratinocytes transfected with UVB damaged DNA display and enhanced IFN-I response compared to controls and to keratinocytes transfected with undamaged DNA. We have identified that knockdown of C/EBPβ results in enhanced activation of Stimulator of Interferon Genes (STING) following transfection with UVB damaged DNA, and STING is required for the enhanced IFN-I response in C/EBPβ-deficient keratinocytes. Together, our findings reveal a STING-dependent mechanism by which keratinocytes detect UVB-induced DNA damage and initiate an IFN-I response and identify C/EBPβ as a critical modulator of this pathway. Understanding these mechanisms will provide deeper insight into how keratinocytes coordinate immune activation and cell fate decisions in response to UVB-induced DNA damage. These insights may have important implications for epidermal diseases such as non-melanoma skin cancer.

Clinical Implications of Visible Light

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Visible light alone, and especially in combination with long wavelength ultraviolet A1 radiation, produces significant and measurable effects on cutaneous biology. This lecture will examine the basic science and translational research underlying visible light–induced changes in the skin.

Emphasis will be placed on clinical consequences, including effects on pigmentation and erythema, and their relevance to photoprotection, post-inflammatory hyperpigmentation, melasma, and rosacea.

Skin cancer in Arizona – an epidemiological perspective

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An ongoing issue in understanding the impact of skin cancers as health care issues for populations is the need for a strong surveillance system. Cancer registries and surveillance systems help us understand the breadth of the issues within a region and identify potential populations at greater risk. The Arizona Melanoma Task Force, founded in 2013, aims to enhance melanoma reporting to the Arizona Cancer Registry (ACR) to promote use of registry data and control of skin cancers. The Task Force began with a group of Arizona researchers and clinicians identifying substantial, >72%, under-reporting of melanoma cases and decreasing incidence rates compared to the rest of the US. This Task Force has identified sources for the under-reporting and barriers to reporting and then implemented strategies to decrease under-reporting to build a better surveillance system. Currently, melanoma is the 4th commonly reported cancer in Arizona, with over 3,410 invasive and 3866 in-situ melanoma cases reported to the ACR in 2022. Based on this work and the high incidence in Arizona, melanoma is part of the Arizona Cancer Control Plan, seeking to maintain this reporting improvement and to focus on decreasing late stage and unknown diagnoses to decrease mortality. Strategies to enhance primary prevention of skin cancers also are being sought as strategies to decrease incidence within our populations. This presentation will provide information on the epidemiology of melanoma in Arizona to highlight the need for research and organizational strategies to reduce skin cancer incidence, morbidity, and mortality.

Structural changes from wild-type define tumor-rejecting neoantigens

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Neoantigen-based immunotherapies hold great promise in the treatment of cancer, but accurately predicting which neoantigens mediate tumor rejection, especially in high mutational burden cancers like cutaneous squamous cell carcinoma (cSCC), remains challenging. Only a small portion of neoantigens prioritized by current methods elicit effective T cell responses, demonstrating the critical need for improved criteria for the prediction of tumor-rejecting neoantigens. We evaluated the neoantigen landscape in human cSCC and found that shared neoantigens were rare, highlighting the need for personalized neoantigen-based immunotherapies. We generated a transplantable UV light-induced cSCC mouse model, which recapitulated the mutational signature and driver mutations found in human disease. In this cSCC mouse model, we identified two tumor-rejecting neoantigens. One neoantigen improved MHC binding compared to the wild-type peptide. For the other neoantigen, the predicted structure presented to the T cell receptor differed. Across known neoantigens that do not impact MHC binding, increased solvent accessibility of the mutated neoantigen residue in the predicted neoantigen:MHC structure distinguished known tumor-rejecting neoantigens from non-immunogenic neoantigens. Thus, structural changes in the exposure of features that promote T cell receptor recognition defined tumor-rejecting neoantigens. Incorporation of structural modeling to predict changes in T cell receptor

accessibility is anticipated to improve the selection of neoantigens for inclusion in personalized cancer vaccines.

Immunoediting restricts clonal neoantigens in human cutaneous squamous cell carcinoma

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Evidence consistent with immunoediting in human cancer is associative. To directly evaluate the immune system's role in sculpting the neoantigen profile, we compared cutaneous squamous cell carcinoma (cSCC) from immunocompetent and immunosuppressed patients. Given the varying degree of immune infiltration in tumors from immunocompetent patients, we further segregated high and low infiltrate tumors. Despite consistency in the mutational signature, high infiltrate tumors from immunocompetent patients have a lower overall mutational burden and a lower clonal mutational burden compared to low infiltrate tumors from immunocompetent patients and tumors from immunosuppressed patients. Additionally, the predicted neoantigen:MHC class I binding affinity decreases with increasing variant allele frequency, demonstrating restriction of mutations encoding binding neoantigens. Finally, highly expressed neoantigens with high predicted MHC class I binding affinity and stability are enriched subclonally in immunocompetent patients. Overall, this work demonstrates the immune system's role in sculpting the neoantigen profile of primary treatment-naïve human tumors.

RNA modifications in UV stress response and tumorigenesis

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N6-methyladenosine (m6A) RNA methylation is the most abundant covalent modification in mRNA and non-coding RNA in eukaryotic cells. m6A mRNA methylation regulates RNA metabolism and gene expression, including RNA decay, translation, and nuclear processing. However, the regulatory and functional role of m6A RNA methylation in UV stress response, cancer development, and therapeutic resistance remains poorly understood. Recently we demonstrated that m6A mRNA methylation regulates genomic integrity and cellular homeostasis under UV stress and controls both tumorigenesis and immunotherapy resistance in melanoma and non-melanoma skin cancer. In addition, we identified the first co-factor that binds to the m6A methyltransferase METTL16 to promote the binding of METTL16 to its RNA targets, leading to increased METTL16 methyltransferase activity, tumor growth, and chemoresistance. Moreover, we discovered the first-in-class molecular glue degrader for the m6A RNA demethylase FTO, which can be induced by UV radiation, leading to increased FTO protein degradation, T cell cytotoxicity, and response to immunotherapy in melanoma. Furthermore, we also demonstrate that m6A methylation in non-coding RNA (ncRNA) regulates its metabolism in UV-induced inflammation and tumorigenesis. Taken together, our findings provide a critical new layer of post-transcriptional regulation of gene expression and RNA signaling by RNA modifications in UV stress response and cancer development.

Molecular mechanisms of UV damage response and skin cancer development

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Ultraviolet (UV) radiation in sunlight as well as tanning beds is a major etiologic factor for skin cancer as well as premature skin aging. Excessive UV radiation causes DNA damage, leading to genome integrity impairment and inflammation, also known as sunburn. As sun protection efforts have not been proven effective, improved targeted chemoprevention strategies are much needed. To achieve this goal, it is paramount to elucidate the molecular mechanisms by which UV damage response is regulated in order to identify new targets for developing new chemo-preventative and therapeutic strategies. To address this knowledge gap, we have been focusing on understanding how our skin cells respond to UV damage and how their homeostatic molecular machinery is hijacked by UV radiation to impair the repair of UV-induced DNA damage and induce inflammation. In particular, we have discovered several critical mechanisms for regulating DNA repair, inflammation, and skin cancer development, including transcriptional regulation of key DNA repair genes, post-translational modifications of the DNA repair protein XPC, cellular metabolism by autophagy, and post-transcriptional modifications and metabolism of mRNA and self non-coding RNA. Moreover, we have identified the first-in-class molecular glue degrader for the m6A RNA demethylase FTO, which can be induced by UV radiation, leading to increased FTO protein degradation, T cell cytotoxicity, and response to immunotherapy in melanoma. Collectively, our findings add new mechanistic insights into a well-coordinated molecular network that links UV damage to skin cancer and may provide previously unrecognized targets for developing improved strategies to reduce skin cancer burden.

Expanding the NIR fluorophore toolbox: A general route to access polymethine-modified Cyanine 9 dyes for deep-tissue imaging

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Light within the visible spectrum (300-750 nm) is limited by the depth of tissue penetration possible, enhanced autofluorescence, and photon scattering from endogenous chromophores. In comparison, light within the near-infrared (NIR) region (≥750 nm) can provide higher spatiotemporal resolution and signal contrast to resolve anatomical structures at a fine scale in deep-tissues. Accordingly, fluorophores within the NIR region have received significant interest for clinical applications in guiding drug delivery, monitoring treatment response, and enhancing tumor resection. To this point, there are no broadly applicable approaches that have been developed to access a library of fluorescent dyes within the 800-900 nm window which would be of significant clinical interest for optical imaging. Here, we report a general methodology for the synthesis of polymethine-substituted enneamethine cyanines (Cy9) that is achieved in two steps. The approach proceeds through a novel intermediate (OxA-chrom4), formed via the reaction of activated pyridinium salts with reactive enolate species. Subsequent condensation of OxA-chrom4 intermediates

with a broad range of indolenine derivatives under mild conditions yields Cy9 fluorophores bearing aliphatic, aromatic, heteroaromatic, and charged substituents termed SAT-NIR-8XX Dyes (San Antonio Near-infrared). The resulting fluorophores display strong NIR absorption and emission, large extinction coefficients, and red-shifted spectra relative to heptamethine (Cy7) analogs, making them suitable scaffolds for deep-tissue fluorescence imaging.

Photosensitizer Nanocrystals as Advanced Platforms for Antimicrobial Photodynamic Therapy

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Most photosensitizers (PS) used in antimicrobial photodynamic therapy (aPDT) often exhibit poor aqueous solubility and bioavailability, limiting their efficacy in vivo. To address these issues, we formulated a diiodo-BOPHY (BP-2I) PS as pure drug nanocrystals using the wet milling technique. This approach yields nearly 100% drug loading, and the stabilizing capping layer further enhances dissolution in biological environments. The process avoids organic solvents and is easily scaled. The synthesis of BP-2I was optimized and performed on a 10-g scale (overall yield >80%). The resulting BP-2I nanocrystals (NC-BP-2I) were thoroughly characterized. SEM, TEM, and DLS analyses confirmed their uniform morphology, monodisperse size distribution, and an average size of ~100 nm. X-ray diffraction further verified the crystalline structure. FTIR, DSC, and TGA analyses confirmed the PS's chemical integrity and thermal behavior. Spectroscopic measurements of NC-BP-2I in water showed that the absorption and fluorescence spectra of BP-2I were retained. Singlet oxygen generation was demonstrated, confirming that the nanocrystal formulation remained photodynamically active. In addition, the nanosuspensions exhibited remarkable long-term stability under multiple storage conditions, showing no detectable changes in size, dispersity, or spectroscopic/photodynamic properties even after more than one year. In aPDT treatments against methicillin-resistant Staphylococcus aureus, NC-BP-2I achieved

>99.999997% photokilling at a concentration of 2.5 μg/mL after irradiation. Importantly, cytotoxicity assays confirmed that the nanocrystals were non-toxic to healthy mammalian cells (MRC-5), supporting their biocompatibility and suitability for biomedical applications. Together, these results further strengthen the potential of NC-BP-2I as robust, stable, and safe platform for enhanced aPDT.

Beyond Cytotoxicity: Photodynamic Priming to Disable Drug Efflux and Restore Therapeutic Response

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Chemoresistance remains a major limitation of cancer therapy, driven in part by ATP-binding cassette (ABC) transporters that actively efflux cytotoxic drugs. Among these, ABCB1 (P-glycoprotein, P-gp) and ABCG2 (breast cancer resistance protein, BCRP) are key mediators of multidrug resistance (MDR). Clinical efforts to inhibit these transporters using small-molecule inhibitors have largely failed due to systemic toxicity and poor tumor selectivity, highlighting the need for alternative, targeted strategies. Here, we describe a decade-long mechanistic and translational investigation revealing that photodynamic therapy (PDT) and photoimmunotherapy (PIT) function not only as cytotoxic modalities, but as selective molecular disruptors of ABC transporter function. Originating from a serendipitous in vitro observation that porphyrin-based photosensitizers photochemically damage ABCG2, this work evolved into integrated in silico, in vitro, and in vivo studies. Upon light activation, porphyrins inhibit ABC transporter ATPase activity, induce photo-dependent protein crosslinking, suppress ABCB1 and ABCG2 expression, and promote mitochondrial priming, collectively impairing drug efflux and restoring chemosensitivity. Mechanistic findings were validated in vivo using targeted intraperitoneal PIT in a mouse model of peritoneal carcinomatosis, a disease state with high MDR prevalence. A well-characterized photoimmunoconjugate (PIC) and clinically translatable light delivery protocol were employed. Following low-dose PIT, tumor cells isolated in vivo exhibited significantly increased intracellular retention of the P-gp substrate Rhodamine 123, providing direct functional evidence of P-gp inhibition without systemic transporter blockade. Together, these results establish phototherapy as a precision, light-activated strategy for disrupting ABC transporter–mediated MDR at its molecular source, offering a mechanistically distinct and tumor-selective approach to overcoming chemoresistance.

Challenges and Opportunities in Treating Malignant Central Airway Obstruction with Interstitial Photodynamic Therapy

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External beam photodynamic therapy (EB-PDT) has been approved to treat primary and metastatic endobronchial malignancies for over 25 years. Its current approval includes inoperable malignant central airway obstruction (MCAO) as well as carcinoma in situ. Despite this, the treatment has suffered from poor adaptation among airway proceduralists for several reasons. First, EB-PDT has limitations in its therapy due to poor light penetration into airway walls, while at the same time having toxicity to normal tissue. Second, endobronchial growth of tumor is not the only mechanism of airway obstruction, which includes intrinsic growth of tumor within airways (intrinsic obstruction), extrinsic pressure of tumor pressing on patent airway walls (extrinsic obstruction), and a combination of the two states (mixed obstruction). EB-PDT can treat intrinsic or mixed obstruction but is less popular than other treatment modalities available. Interstitial PDT (I-PDT) is an experimental therapy which offers an exciting treatment option for extrinsic obstruction, currently a disease state with few therapeutic options. I-PDT involves inserting a small caliber optical fiber through the airway directly into the tumor. I-PDT has the advantage of increased light penetration while sparing healthy tissue. I-PDT faces other challenges however, including treating very large tumors and effectively avoiding vital vascular structures. Some of these challenges can be addressed with pre-treatment planning. This presentation proposes to cover details on the clinical challenges of MCAO, the pitfalls of EB-PDT and the challenges and opportunities of I-PDT in the thoracic airway space.

Photochemistry and Frozen Matrix Studies of Substituted N-Phenyl Dibenzothiophene Sulfoximines

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UV-A irradiation of N-phenyl dibenzothiophene sulfoximine results in cleavage of the S–N bond to generate phenyl nitrene and dibenzothiophene S-oxide (DBTO). Subsequent photolysis of DBTO releases triplet atomic oxygen. Dual photochemical release of two distinct

reactive intermediates from a single chromophore is rare. This work investigates whether the sequence of reactive intermediate release can be reversed, enabling atomic oxygen formation to precede nitrene generation. Current research focuses on modulating the electronic properties of the S–N and S–O bonds by incorporating various electron-donating groups (EDGs) and electron-withdrawing groups (EWGs) directly at the S–N bond and around the dibenzothiophene ring. Furthermore, we explore the photochemistry of these chromophores within a frozen matrix. Current results indicate electron-withdrawing substituents on either the N-aryl group or the 2-position of the DBT ring increase the quantum yield of DBTO formation, whereas electron-donating N-aryl substituents and N-alkyl substitution—regardless of steric branching—either decrease or show little to no increase in the quantum yield of DBTO formation. Collectively, these observations suggest that electronic modulation of the sulfoximine bonds can occur either directly via the S–N bond or indirectly through the DBT ring system. Ongoing studies probe the reactivity of the two intermediates within a frozen matrix and assess how electronic modulation influences control over the sequence of reactive intermediate release. Together, these findings show that substituent electronics play a decisive role in governing sulfoximine photoreactivity and may enable deliberate control over the order of reactive intermediate generation.

Extended photolysis for molecule downsizing: A biomimetic polyprenyl chain-shortening in phenolic precursors to plant defense molecules

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Here we combine biomimetic photooxidation experiments with density functional theory (DFT) to elucidate the sequence and energetics of prenyl-chain degradation and fragmentation pathways in polyprenylated phenols. Singlet oxygen ($^1O_2$) is a key reactive species in these transformations. Polyprenylated phenols are common biosynthetic precursors to dihydrobenzofurans (DHBs) that undergo sensitized photooxidation to yield DHB products or fragment into lower-molecular-weight species. Detailed NMR characterization, supported by DFT calculations, reveals the formation of hydrogen peroxide, formaldehyde, methacrolein, and methane, consistent with stepwise prenyl-chain shortening via oxidative fragmentation. The calculated activation barriers for these processes are accessible, ranging from ~6 to 16 kcal mol^{-1}. Collectively, these results support a mechanism of molecular "whittling" of polyprenyl chains under prolonged photooxidative conditions, providing a biomimetic route to plant defense molecules such as tremetone.

Machine learning–optimized photothermal microparticles for repeatable, localized combination cancer therapy

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Progressive solid tumors often require repeated treatment, but systemic therapies are constrained by cumulative toxicity and poor spatiotemporal control. We present a minimally invasive, depot-based therapeutic platform that enables localized, pulsatile cancer treatment via external near-infrared (NIR) activation. Poly(caprolactone) microparticles (~200 µm) incorporating molybdenum disulfide (MoS_2) nanosheets were loaded with hydrophilic or hydrophobic chemotherapeutics. NIR irradiation induces localized photothermal heating (≥50 °C), transiently softening the polymer matrix to enable synchronized thermal ablation and on-demand drug release. A machine-learning–guided framework optimized irradiation parameters to achieve precise thermal control at low power densities (0.4 W cm^{-2}). In a murine 4T1 triple-negative breast cancer model, a single intratumoral dose followed by three irradiation cycles produced sustained tumor regression and more than doubled median survival relative to controls, with complete local tumor eradication. This approach demonstrates a potential strategy for repeatable, localized cancer therapy that decouples efficacy from systemic exposure.

Harnessing structure-guided optogenetic tool engineering for advanced Cell Signaling Manipulation

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Cells respond to time-varying, spatially heterogeneous chemokine signals in vivo, activating cell-surface proteins like G protein-coupled receptors (GPCRs). The Gαq pathway, initiated by GPCRs, is significant in various physiological and pathological processes, including immune responses and neurodegeneration. The specific processes affected by Gαq signaling remain under investigation to develop targeted therapeutic strategies. GαqGTP activates crucial effectors, such as PLCβ (Phospholipase Cβ) and Rho GEFs (Rho guanine nucleotide exchange factors). We engineered and validated OptodHTH, a selective optogenetic inhibitor that reversibly disrupts GαqGTP-PLCβ interactions, enabling precise manipulation of G-protein signaling in live cells. This selectivity enables in-depth exploration of Gαq signaling dynamics in various biological contexts. Additionally, we employed in silico, structure-guided engineering to generate a novel optogenetic guanine nucleotide dissociation inhibitor (GDI) using the G-protein regulatory motif of the relatively unexplored protein Activators of G-protein signalling 3 (AGS3). Our findings show that OptoGDI effectively releases Gβγ, stimulating localized PIP3 generation and triggering macrophage migration. This highlights the potential applications of our tools and raises questions about adapting these techniques for different cell types and tissues. Overall, our molecular tools allow for optically dissecting signaling pathways with precise spatio-temporal control in cells and in vivo. However, understanding the limitations of optogenetic tools in live-cell experiments remains essential for optimizing their effectiveness across varied conditions. Future research should aim to address these challenges to enhance the utility of optogenetic strategies for elucidating complex signaling networks.

Investigating structure-activity relationships of photoactive metallodrugs as antimicrobials

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The rapid emergence of antimicrobial resistance continues to outpace efforts to develop new antibiotics. Conventional antimicrobial agents typically act by inhibiting essential steps in metabolic pathways critical for pathogen survival. However, bacteria can evolve to circumvent these mechanisms, rendering many antibiotics ineffective. To counter this threat, complementary therapeutic strategies are urgently needed. Photodynamic inactivation (PDI) is a promising alternative approach that exploits light–molecule interactions to eradicate bacterial infections. PDI employs a photosensitizer (PS)—a nontoxic compound that, upon light activation in the presence of oxygen, produces cytotoxic reactive molecular species (RMS), including singlet oxygen. This localized and immediate burst of RMS provides a mechanism for bacterial killing that

is largely independent of traditional antibiotic resistance pathways. Our research focuses on developing new photoactive metallodrugs as photosensitizers and systematically modifying their structures to elucidate structure–activity relationships. These insights will guide the design of next-generation lead compounds with enhanced antimicrobial efficacy. This presentation will highlight how specific structural modifications influence light-induced cytotoxicity and antibacterial activity across different bacterial strains.

Mechanistic Insights into Enhanced Thymine Dimer Formation under Pulsed UVC Irradiation

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UVC disinfection is a non-contact sterilization technique that inactivates microorganisms without the use of chemical agents and is widely applied in the medical, food, and environmental fields. Its primary mechanism involves DNA damage via thymine dimer formation. Although high-dose UVC irradiation achieves effective inactivation, it can also cause damage to non-target materials. Pulsed UVC irradiation has recently been reported to enhance inactivation e ciency at lower doses. While this enhancement is often attributed to photothermal e ects caused by high peak power, increased inactivation has also been reported under low average power conditions, where the underlying mechanism remains unclear. In this study, we investigated the mechanism responsible for the enhanced inactivation induced by pulsed UVC irradiation under low average power conditions. CW and pulsed irradiation were applied to plasmid DNA solutions and plasmid-transfected bacterial cultures to evaluate thymine dimer formation and microbial inactivation.

Interestingly, pulsed irradiation increased both thymine dimer formation and inactivation in bacterial cultures compared with CW irradiation, whereas no difference was observed in plasmid DNA solutions. To further investigate the reaction timescale involved in inactivation, we varied the UVC pulse repetition frequency from 10Hz to 10kHz. The superiority of pulsed irradiation over CW irradiation persisted across all tested frequencies. These results suggest that enhanced inactivation by pulsed UVC irradiation may arise from an indirect thymine dimer formation pathway mediated by intracellular components, and it operates on a millisecond-to-second timescale. This study provides mechanistic insight into pulsed UVC disinfection and supports its potential for effcient, low-dose sterilization applications.

Transcriptional profiling of cutaneous squamous cell carcinoma reveals subtype-specific regulatory programs and therapeutic vulnerabilities

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Cutaneous squamous cell carcinoma (cSCC) exhibits marked histologic and differentiation-state heterogeneity, with poorly differentiated (PD) tumors associated with substantially worse clinical outcomes compared with well differentiated (WD) lesions. To define the molecular programs underlying subtype-specific aggressiveness, we performed bulk RNA sequencing of human normal skin (NS, n = 6), WD cSCC (n = 6), PD cSCC (n = 6), and metastatic PD cSCC (PD-M, n = 3) samples. Integrated transcriptomic analyses identified distinct expression signatures and regulatory networks across cSCC subtypes. PD and PD-M tumors demonstrated suppression of keratinization pathways, potentially linked to altered expression of the long noncoding RNAs TINCR and LINC00941. These subtypes also exhibited reduced cholesterol biosynthesis, accompanied by decreased SREBF2 expression. In contrast, all cSCC subtypes showed activation of cell cycle–associated gene programs, likely driven by upregulation of MYBL2 and FOXM1, alongside enhanced immune signaling associated with downregulation of the transcriptional repressor ETV3. Therapeutic target profiling revealed multiple actionable vulnerabilities, including immune checkpoint pathways and mediators of stromal–immune interactions, several of which are targetable with FDA-approved or investigational agents. Additionally, transcriptomic analysis identified candidate extracellular biomarkers with diagnostic potential, including EPGN (enriched in WD), FN1 (enriched in PD and PD-M), and CXCL1 (enriched in WD and PD). Together, these findings define subtype-specific regulatory programs in cSCC and provide a molecular framework for precision diagnostics and targeted therapeutic strategies.

Alloxazine derivatives as multifunctional agents for photodynamic therapy, cancer cell imaging and cell proliferation inhibition

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Photodynamic therapy (PDT) is a clinically approved, non-invasive therapy for the treatment of cancer that has attracted worldwide interest due to its spatioselectivity and fewer side effects. PDT employs the use of a photosensitizer (photoactivable drug) that generate singlet oxygen (1O2) and reactive oxygen species (ROS), upon photoactivation by a specific wavelength of light, which are detrimental to the targeted malignancies. The development of biocompatible organic photosensitizers remains an important challenge for advancing image-guided photodynamic therapy. Specifically, photosensitizers that combine strong photodynamic activity, fluorescence emission for bioimaging, decrease or stop the proliferation of cancer cells, and allow synthetic accessibility are in high demand. Herein, we report the synthesis and characterization of a new class of alloxazine-based photosensitizers (ANOMe, A8OMe and A7OMe). They are engineered through sugar conjugation and structurally modified at the C7 and C8 positions with electron-donating methoxy groups to tune their photochemistry and photobiology. These photosensitizers exhibit efficient population of long-lived triplet states, near unity singlet oxygen quantum yields, and fluorescence, as revealed by steady-state spectroscopy, time-correlated single-photon counting, and nanosecond transient absorption spectroscopy. Computational studies (DFT and TD-DFT) are combined with experimental data to disclose their electronic relaxation mechanisms. In vitro cellular assays demonstrate that these photosensitizers enter the cytoplasm, generate cytotoxic reactive oxygen species upon light activation, exhibit substantial fluorescence, and can significantly slow down the proliferation of cancer cells in the absence of light. Collectively, the experimental and computational results demonstrate the utility of rationally designed alloxazine derivatives as multifunctional agents for image-guided photodynamic therapy.

Protein tyrosine dephosphorylation signaling in the regulation of UVB-induced epidermal apoptosis

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T-cell protein tyrosine phosphatase (TC-PTP) is one of intracellular, nonreceptor PTPs that is ubiquitously expressed in embryonic and adult tissues. Studies have shown that TC-PTP has crucial roles in the regulation of the immune response, insulin signaling, and oncogenic signaling, mainly by regulating JAK/STAT signaling. We demonstrate that TC-PTP has a protective function during UVB-induced damage in skin. TC-PTP-KO transgenic mice showed significant resistance to UVB-induced apoptosis in epidermis compared to wild-type mice, which was concomitant with a UVB-mediated increase in the level of Flk-1 phosphorylation.

Immunoprecipitation analysis using the TC-PTP substrate-trapping mutant TCPTP-D182A indicated that TC-PTP directly interacts with Flk-1 to dephosphorylate it in keratinocytes and their interaction was stimulated by UVB irradiation. Following UVB-mediated Flk-1 activation, the level of JNK phosphorylation was also significantly increased in TC-PTP KO keratinocytes compared to control keratinocytes. In addition, the expression of LC3 was significantly increased in TC-PTP/KO keratinocytes compared to control keratinocytes following UVB irradiation.

Increased expression of LC3 in TC-PTP/KO keratinocytes was accompanied by a significant decrease in expression of the p62. Similarly, TC-PTP overexpression in mouse epidermis revealed significant sensitivity to UVB-induced apoptosis compared to wild-type mice. Further studies showed that p38 MAPK phosphorylation was increased in TC-PTP-overexpressing keratinocytes with a significant increase in the levels of cleaved Caspase-3 and PARP compared to control keratinocytes. Collectively, our findings reveal insights into the protective role of TC-PTP against UVB-induced skin damage via the negative regulation of Flk-1/JNK and autophagy signaling pathways and the positive regulation of p38 MAPK signaling pathway.

Quantum computing meets AI: a new frontier for virtual screening of photosensitizers and photocatalysts

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A rational design of photocatalysts and phototherapeutic agents requires accurate predictions of excited-state energetics, intersystem crossing (ISC) pathways, and electron-transfer reactivity. However, these properties at scale often entail strongly correlated electronic structures of the photo-active molecules that pose as challenging problems of conventional quantum-chemical methods. Here, we present a new computational framework that combines quantum-enhanced electronic-structure tools with data-efficient machine-learning approaches to overcome these limitations and enable predictive modelling of photocatalysts with a particular focus on photosensitizers for photodynamic therapy (PDT) and antimicrobial photodynamic therapy (aPDT).

In this work, we will discus the development of a quantum-boosted active-learning pipeline for transition-metal complexes where high-quality excited-state data from quantum-enhanced simulations guide machine-learning models that efficiently explore vast design spaces and optimize key photochemical descriptors, including triplet-state energies, spin-orbit-coupling—mediated ISC rates, and Type-I PDT redox criteria. Together, these advances establish a scalable and chemistry-centric platform for the predictive design of next-generation photosensitizers and photocatalysts, directly addressing long-standing bottlenecks in modelling complex excited-state reactivity.

Ultrafast photophysics in DNA and eumelanin

Bern Kohler

The Ohio State University, Columbus, OH

Visible and UV light can create excited electronic states, which nature puts to good use in natural photosynthesis, but these energy-rich species can also initiate damaging photoreactions. Using femtosecond laser spectroscopy, my research group has spent many years studying the mechanisms behind ultrafast excited-state deactivation in DNA and in the brown-black melanin pigment known as eumelanin. Excited states in each have ultrashort lifetimes that enhance their photostability on a planet bathed in sunshine. In many organisms including humans, eumelanin acts as a natural sunscreen to reduce rates of DNA photodamage, but these two "biopolymers" could hardly be more different. DNA is assembled from a precise template with high fidelity by multiple enzymes. In contrast, eumelanin, which is produced by radical-driven reactions with minimal enzymatic control, forms nanoparticles from subunits with unknown atomistic structures and is likely not a high molecular weight polymer. Supramolecular structures present in each cause their emergent photoproperties to differ significantly from those of their smallest building blocks. In DNA, sub-picosecond excited-state lifetimes are observed in the nucleobase monomers due to readily accessible conical intersections. Much longer excited state lifetimes and rich deactivation mechanisms involving photoinduced electron and proton transfer occur in DNA strands. While structural knowledge of canonical and non-canonical DNAs is extensive, the supramolecular motifs and even the basic chemical structures present in eumelanin are obscure. Progress at emulating eumelanin photoproperties through the "bottom up" synthesis of model compounds with precisely defined structures will be described. In addition, "top down" studies of synthetic eumelanin nanoparticles using transient spectral hole burning spectroscopy and atomic force microscopy will be presented. These results have led to a new model in which the photoproperties of eumelanin emerge from interactions among coupled chromophores present in a heterogeneous ensemble of ultrasmall nanostructures.

Ultrafast Excited State Dynamics of Silver ion-DNA supramolecular assemblies

Bern Kohler

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Metal ions are vital contributors to the final structures adopted by DNA and RNA. Many metal cations interact most of the time non-specifically with the negatively charged phosphate groups. However, metal ions and protons sometimes coordinate directly to the nucleobases as exemplified by G quadruplex and i-motif DNA structures, expanding the space of nucleic acid structures that have biological and nanotechnological importance. Some metal ions coordinate very strongly to the nucleobases even in dilute solution conditions. These ions direct the formation of a wide variety of supramolecular assemblies organized around building blocks such as metal-ion mediated base pairs and coordination polymers. The ability of metal ions to dramatically alter the spatial organization of nucleobases can profoundly alter their excited-state dynamics, making ultrafast laser spectroscopy a valuable probe of structural dynamics. My research group has been using femtosecond laser spectroscopy to study the photophysics of supramolecular assemblies formed between DNA nucleobases or strands

and silver(I) ions. Some investigators have suggested that silver(I) ions can substitute for protons and form i-motif-like structures composed of silver ion-mediated base pairs. Our work indicates instead that these structures form parallel-stranded duplexes made of C-silver(I)-C base pairs with very high propeller twist. TRIR experiments reveal the formation of a long-lived triplet excimer state in these assemblies, which nevertheless does not enhance photodamage.

Harmonizing In Vivo Visible Light Phototesting: Methodologic Variability and Consensus Recommendations

Indermeet Kohli, PhD

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Visible light (VL) is now recognized to elicit biologic effects in skin across all phototypes; however, standardized phototesting protocols are currently lacking. Existing in vivo studies demonstrate considerable variability in light sources, dosing, exposure schedules, assessment methods, and calculation of VL protection factors (VL-PF). This presentation will discuss the key methodological differences in human VL studies. Proposed strategies for harmonization and consensus recommendations from an international expert panel will also be presented.

Establishing standardized VL phototesting is critical for enabling reproducible study comparisons and accurate determination of VL-PF.

Antimicrobial Photodynamic Inactivation with 2,3-Distyrylindoles

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The rising global crisis of antibiotic resistance necessitates the urgent development of novel therapeutic approaches. We report the discovery of photoactivated bactericidal properties in compounds based on the 2,3-distyrylindole scaffold, which offers significant promise as a light-controlled antimicrobial agent. The compounds are readily prepared via a one-step synthesis using the oxidative Heck reaction of indole with substituted styrenes. This convergent approach, which assembles three fragments (indole and two styrene units), is simple and amenable to the preparation of a large number of diverse analogues. The lead compound, p-chloro-substituted derivative, demonstrated significant activity upon a 2-minute irradiation with white light. At 1 μM, it completely eradicated Gram-positive organisms, including MRSA, S. pyogenes, and VRE. For Gram-negative bacteria, a combination of this compound (5 μM) and polymyxin E (PME) resulted in a 7-log to 9-log reduction in bacterial counts for multi-drug resistant strains A. baumannii, P. aeruginosa, and CRE. Mechanistic studies, including SEM imaging and propidium iodide staining, indicate that the effect involves the disruption of the bacterial cell membrane. However, we were unable to detect singlet oxygen generation, indicating that the effects of these compounds are different from conventional photodynamic therapy. We are currently pursuing extensive structure-activity relationship and spectroscopic studies of these promising compounds to optimize their photoactivated bactericidal properties. The results of these efforts will be presented at the conference.

Photodynamic Treatment Of Glioblastoma Plus Endothelial Cell Spheroid Models: Increased Proliferative And Migratory Aggressiveness Of Surviving Tumor Cells Due To Inos/No Upregulation

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Photodynamic therapy (PDT) is a unique oxidative stress-based anti-tumor modality that has proven highly eLective for various solid malignancies. Intrinsic and acquired resistance is a significant challenge for all cancer treatments, including PDT. We shoved previously that several human cancer cell lines in 2D cultures can exploit nitric oxide (NO) from stress-upregulated inducible nitric oxide synthase (iNOS) to (i) resist photokilling sensitized by 5-aminolevulinic acid (ALA)-induced protoporphyrin IX, and (ii) promote growth and mobility aggressiveness of surviving tumor cells. We describe here a mixed-spheroid model consisting of glioblastoma (LN229 or U87) cells and normal human (HMEC) epithelial cells. Using high resolution confocal microscopy, we visualized the process of development of heterospheroid models. We analyzed the distribution of ALA-induced protoporphyrin IX within preformed spheroids. PpIX formed initially in the periphery of spheroid reaches even distribution within the spheroid in ~12 h of equilibration time. The survival of spheroid cells subjected to photodynamic action was determined. In general, higher doses of LED light were needed to achieve the same killing ratio for spheroids, as compared to 2D cultures. The eLects of ALA/light treatment on the expression of iNOS, and proliferative potential of surviving tumor cells are reported. The impact of iNOS inhibitor (1400W) on the process of spheroid re-growth after induced photodynamic action was also analyzed. Photodynamic stress of glioma cells spheroids increases their intrinsic iNOS expression and NO-dependent proliferation. This increase is inversely proportional to the initial/constitutive expression of iNOS: less aggressive LN229 cells show a greater stress-induced increase in iNOS and proliferation than constitutively more aggressive U87 cells. These findings suggest that introduction of an iNOS inhibitor could significantly increase the eLectiveness of photodynamic therapy at the clinical level.

Optically detected magnetic resonance in fluorescent proteins

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Optically detected magnetic resonance (ODMR) enables direct magnetic-field readout by monitoring spin-dependent fluorescence, forming the basis of emerging quantum sensing technologies. The nitrogen-vacancy (NV) center in diamond is the most established ODMR-active system, widely used for nanoscale magnetometry, thermometry, and goniometry. However, NV-based sensing faces major barriers in biological environments due to the rigidity and chemical inertness of diamond, limited scalability, and challenges with biocompatibility. Recently, enhanced yellow fluorescent protein (EYFP) was shown to exhibit time-resolved ODMR arising from a metastable triplet state of its native fluorophore, effectively functioning as an optically addressable spin qubit. Strong ODMR or magnetic field effects (MFE) have also been observed in other fluorescent proteins, including MagLOV, DmCry, and mScarlet3. These proteins offer compelling advantages as next-generation quantum sensors: genetic encodability, tunable structure, scalability, small size, and high structural homogeneity. Such features open the door to quantum measurements directly within living systems, enabling biological insights previously out of reach. Our research aims to advance the fundamental understanding of fluorescent-protein qubits and accelerate their development for quantum sensing. Because the field is nascent, the relationship between protein conformational dynamics and quantum performance remains unexplored. To address this gap, we combine light-modulated nuclear magnetic resonance (NMR) spectroscopy, selective isotopic

labeling, and ODMR measurements to probe how conformational fluctuations influence qubit dephasing and decoherence. We have expressed and purified recombinant proteins with diverse isotopic labeling schemes and have progressed with detailed characterization. The resulting insights will guide the engineering of protein-based qubit platforms with enhanced quantum sensing capabilities.

Metal-Based Photosensitizers Design using Quantum Chemical Computational for Photodynamic Therapy

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Photodynamic therapy (PDT) relies on molecular photosensitizers, such as porphyrins, phthalocyanines, and metal-chelated bipyridines whose electronic structure and excited state dynamics controls key photophysical properties such as absorption, and reactive oxygen species (ROS) generation. Designing next-generation photosensitizers requires reliable prediction of excited-state properties, spin–orbit coupling, and intersystem crossing (ISC) rates. Computational methods provide reliable means to systematically investigate chemical modifications that improve PDT efficacy while shifting absorption into clinically relevant near-infrared regions. Here, we report a time-dependent density functional theory (TDDFT) investigation of metal-based photosensitizers. TLD1433 is a ruthenium-based that has a central bipyridine core chelating a ruthenium atom, and a side chain made of three linked thiophene rings. Based on this structure as a foundation, we investigated different central metal atoms (ruthenium, rhodium, osmium, iridium, and platinum) and heteroaromatic chalcogenated side chains (furan, thiophene, selenophene and tellurophene) impacting the photophysical parameters. For each structure, the lowest energy optically allowed transition was identified and used as a basis for comparing oscillator strengths, spin orbit coupling magnitudes, ISC rates, vertical electron affinities, and vertical ionization potentials. The presented computational framework enables rapid screening of photosensitizer candidates and provides transferable design principles for photoactive molecular systems relevant to phototherapy and photobiological applications.

The Potential of Carbon Nanomaterial as New Active Ingredients in Sunscreens

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Skin cancer, as the most common type of cancer, is primarily caused by the exposure to ultraviolet (UV) light. Wearing sunscreen is the most common recommended method for skin cancer prevention. Sunscreens contain active ingredients that absorb different parts of the UV spectrum. However, small-molecule UV absorbers have limitations, including dermal penetration, photodegradation, and generation of reactive oxygen species (ROS). These shortcomings highlight the need for next-generation photoprotective actives that are photostable, non-penetrating, and capable of reducing UV-induced oxidative stress.

This study evaluates carbon nanomaterials, such as graphene oxide (GRO) and carboxylated multi-walled carbon nanotubes (CoCNT) as potential sunscreen active ingredients. Their broad-spectrum UV absorbance, photostability, and in vitro protection factors were compared with commercial sunscreen actives using ISO 23675:2024 (SPF) and ISO 24443:2021 (UVAPF) protocols. GRO exhibited approximately a two-fold enhancement in both SPF and UVAPF relative to commercial actives, while CoCNT achieved seven-fold higher SPF and five-fold higher UVAPF in identical vehicles. Both materials demonstrated exceptional photostability under UV doses equivalent to two hours of midday summer sunlight in Cleveland.

To assess biological relevance, UV-induced ROS were quantified in MelanoDerm, reconstructed human skin, and in murine dorsal skin following topical application. Both GRO and CoCNT significantly reduced UV-generated ROS in human skin and murine models. Ongoing studies using HGF/SF mice, the UV-induced melanoma model, will demonstrate the role of these carbon nanomaterials in melanoma prevention.

UV-Driven Selection of Early Life Codons

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Ultraviolet (UV) light threatens the integrity of the genetic code. Despite detailed studies on the photostability of DNA mononucleotides, the UV susceptibility of short single stranded DNA oligonucleotides is not thoroughly understood. [1] We recently studied UV-driven self-repair, a non-enzymatic protection mechanism, and found a strong sequence selectivity in short DNA oligonucleotides under UV exposure. [2-4] Here, we investigate the UV-induced sequence selectivity of short DNA oligonucleotides in a broad sequence pool, closing the gap between top-down and bottom-up approaches to understanding the emergence of life prior to the last universal common ancestor (LUCA).[5,6] Using a Monte Carlo method combined with next-generation sequencing data from experiments, we quantified the UV susceptibility of proto-genomes as they likely could have emerged on early Earth. Our results show surprising compatibility with genetic code evolution models, suggesting that UV light may have been a critical selection pressure in the development of early life.

Natural and Synthetic Optogenetic Circuits: mapping transcriptional responses and visualizing population dynamics through the eyes of fungi

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The filamentous fungus Neurospora crassa perceives and responds to light through the White-Collar Complex (WCC), a transcriptional heterodimer containing a LOV (Light-Oxygen-Voltage) domain that senses blue wavelengths. Light absorption triggers a conformational change that promotes dimerization and results in strong, light-intensity dependent transcriptional activation.

We have adopted optogenetic approaches to further delve into Neurospora's light-responses.

In doing so, we were able to genetically program 2D-images in this organism. Thus, we can project a photograph onto a Neurospora carrying a luciferase reporter under the control of a light responsive promoter and obtain back a bioluminescent pattern mimicking the original image: a live canvas in which images are genetically processed and reproduced with real-time dynamics. This platform provides a great way to assess transcriptional profiles obtaining (literally!), a picture of gene expression, and also to explore the properties of genetic circuits, circadian systems, and transcriptional (eidetic) memory. We have even developed a cybergenetic platform that allows us to precisely "print" genetic responses through computer-controlled light stimulation.

In addition, we engineered Neurospora-based optogenetic switches for Saccharomyces cerevisiae, enabling robust blue-light–responsive transcriptional systems. In yeast, we can now achieve over 3000-fold induction of gene expression across a wide dynamic range, and by switching the lights on and off, we can control biotechnologically relevant phenotypes such as flocculation. Moreover, by integrating exocrine and optogenetic systems, we have generated complex population dynamics, illustrating how light can function as a potent orthogonal signal to reprogram both individual and collective traits. These approaches have opened the door to studying population behaviors -including the emergence of mutualism- in the emerging field of Optoecology.

Light Transmission as an Indication for Response to Interstitial Photodynamic Therapy

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Interstitial Photodynamic Therapy (I-PDT) is being employed for the treatment of large and deeply seated tumors. In I-PDT, therapeutic laser light is transmitted through optical fibers inserted into the target tumor for effective illumination and activation of the photosensitizer. Computer simulations of light propagation are used to guide I-PDT light delivery for maximizing light dose (fluence) and dose rate (irradiance or fluence rate) within the target tumor while protecting adjacent normal tissue. We have recently reported that controlling the fluence and irradiance at the tumor margins is essential to achieve ≥ 86% cure in mouse models treated with I-PDT. Our research team developed a light dosimetry system that can be utilized to measure the irradiance and fluence during I-PDT. This system was used to investigate the relationship between changes in light irradiance during I-PDT and tumor response of locally advanced squamous cell carcinoma VII and Lewis lung carcinoma in, respectively, C3H and C57BL/6 mice. Our data demonstrate a decrease in the transmitted light irradiance over the course of light delivery. The decrease in irradiance is attributed to changes in tumor optical absorption and reduced scattering coefficient during I-PDT. In this talk we will demonstrate that light transmission during I-PDT is a possible dosimetric marker for tumor response and present a new technology that can improve the control of light delivery during I-PDT.

Epigenetic regulation of UV-induced photoaging: shared molecular pathways in skin carcinogenesis

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Skin aging is an actively regulated process governed by the epigenome. Ultraviolet (UV) radiation, a primary driver of photoaging, translates transient environmental insults into a persistent aged phenotype by orchestrating epigenetic changes that degrade the extracellular matrix (ECM). This process is driven by two principal mechanisms. First, UV-induced DNA hypermethylation, mediated by the upregulation of DNMT1, systematically silences protective genes like TIMP2 and CRAT, thereby removing critical brakes on ECM breakdown. Second, UV exposure causes profound shifts in histone modification patterns, including the downregulation of key histone deacetylases like HDAC4, which simultaneously promotes cellular senescence and MMP-1 expression. Multifaceted regulators such as EZH2 further execute a "pincer movement" on the ECM, concurrently promoting collagen degradation and suppressing its synthesis through distinct mechanisms. Notably, these epigenetic alterations in photoaging share common molecular pathways with UV-induced photocarcinogenesis, including DNMT1-mediated silencing of tumor suppressors and senescence-associated secretory phenotype (SASP) that creates a pro-tumorigenic microenvironment. In conclusion, skin aging is an epigenetically programmed assault on the dermal matrix. This understanding shifts the future of anti-aging dermatology toward targeted "epigenetic drugs" designed to rewrite these aberrant marks and restore a more youthful gene expression profile, potentially offering dual benefits in both photoaging prevention and skin cancer chemoprevention.

Non-chemical growth control of plants using far-UV (222 nm)

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Independent expert, The Netherlands

Most applications of far-UV are related to disinfection. In this contribution a new application will be presented: non-chemical growth control of plants.

For many reasons it can be desirable to be able to control plant growth, e.g. for aesthetics, for cheaper & easier transportation, to be able to control the time of blossoming, to stimulate a higher concentration of certain desired substances in the plant, etc. Also it can be useful to favor growth of certain plant species over others (e.g. crop vs. weed).

Often chemicals are used for growth control, but non-chemical and environmentally friendly solutions are increasingly desired, e.g. in biological agriculture.

Far-UV promises to be more effective than traditional UV-C, because it (also) affects other molecules than DNA and is much less prone to photoreactivation. Moreover, it is much safer in case people or fauna would be exposed unintentionally.

For experiments, test plants were grown in soil in grow trays. Exposure took place several days after sowing, when the seedlings were a couple of centimetres high.

Garden cress, cucumber, tomato, spinach i.a. all showed a (inverse) height dependence on far-UV dose several days after exposure.

Also, some preliminary indications suggest that low doses of far-UV may strengthen plants.

The results of these exploratory experiments are very promising for the application of far-UV for growth control of plants, since a clear effect of far-UV on the plant size has been observed, even for a single exposure with a limited dose.

ERLIN Proteins and Keratinocyte Survival Following Solar UV

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Endoplasmic reticulum (ER) raft-associated proteins 1 and 2 (ERLIN1/2) are important regulators of cholesterol synthesis. A stable ERLIN1/2 knockdown using shRNA was established in HaCaT keratinocytes. Resazurin viability assays indicated that ERLIN depletion has a protective effect following solar ultraviolet (sUV) exposure. Additionally, we observed that sUV impairs activation of sterol regulatory element binding proteins (SREBPs) and reduces 3-hydroxy-3-methylglutaryl-CoA reductase (HMGCR) expression at both protein and mRNA levels. However, these effects were unchanged in ERLIN1/2 knockdown cells. Therefore, the cholesterol synthesis pathway is unlikely to account for the enhanced survival observed in ERLIN1/2-depleted keratinocytes.

Currently, the role of ER stress and the unfolded protein response (UPR) in mediating the increased cell survival of ERLIN1/2 depletion is being investigated. ERLINs are associated with ER quality-control mechanisms, including ER-associated degradation (ERAD), and have been linked in other systems to regulation of the IRE1α/XBP1 signaling axis. The UPR is a central stress response that determines cell fate under conditions of ER stress, such as sUV irradiation. Importantly, the IRE1α/XBP1 branch of the UPR is considered an adaptive pathway, supporting cell survival by enhancing protein folding and clearance. We hypothesize that ERLIN depletion may stimulate the UPR pathway in keratinocytes post-sUV, explaining the improved cell viability.

DNA photoreactivity and photorepair: the legacy of Miguel A. Miranda

Virginie Lhiaubet-Vallet

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This presentation will provide a synopsis of the seminal contributions made by Miguel A. Miranda, who passed away in October of last year, throughout his distinguished career. It will focus in particular on his work addressing DNA photoreactivity with two major contributions: the determination of the thymine triplet excited state energy in DNA, and the Trojan horse concept (ie. intrinsic DNA photosensitization). The focus of this talk will also encompass recent advancements in the domain of photophysics and photoreactivity of etheno adducts, which are generated as a result of metabolic processes. The photochemistry of three mutagenic DNA adducts – 3,N4-etheno-2'-deoxycytidine (εdC), 1,N2-etheno-2'-deoxyguanosine (εdG), and 1,N6-etheno-2'-deoxyadenosine (εdA) – will be addressed through a combined experimental/ theoretical study of εdC and εdG showing the effect of the extra heterocycle compared to native nucleobases. The photochemical reactivity of εdA and εdG, triggered by two well-known photosensitizers acting by Type I and/or Type II mechanisms, has revealed to result in a partial photorepair. Therefore, with the objective of shifting the excitation wavelength towards the photobiological window, upconverting nanohybrids derivatized with a covalently linked rose Bengal (UC@RB) have been developed. These nanohybrids act as light-harvesting nanozymes, absorbing NIR-light and transferring energy to rose Bengal, thereby triggering the photorepair of these DNA purine-derived etheno adducts.

Photosensitizer, light and biological response: how many photons are needed?

Lothar Lilge[1], Tina Saeidi[1], Shuran Wang[2], Vaughn Betz[2], Brian Wilson[1]

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Indications for Photodynamic Therapy are increasing, particularly for interstitial and intracavity applications. While the placement of light sources becomes more complex, PDT dosimetry and personalized treatment planning do not appear to play a significant role in treatment delivery. Mostly empirically determined wavelength and host tissue dependent source densities are applied to cover the clinical target volume. The average light energy density to be delivered to the target was determined empirically in clinical studies, evaluating population-averaged clinical responses, and variability in local PDT eJicacy determining parameters is not considered. Can dosimetry based on the spatial colocalization of PDT dose parameters improve eJicacy while reducing light exposure mediated morbidity? Methods for predicting tissue necrosis based on explicit or implicit dose metrics have been proposed but are still rarely used clinically. How can we enhance our understanding of tissue responses across photosensitizers? More importantly, what are the PDT doses for non-standard PDT delivery schemes, such as metronomic PDT of FLASH-PDT or when non-necrotic biological endpoints, such as photoimmunotherapy, are considered? In this invited talk, the knowns in PDT dosimetry are briefly summarized, and the unknowns that the community should collect are suggested.

PaX dyes — photoactivatable fluorophores for live-cell and multicolour nanoscopy

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The controlled switching of fluorophores between non-fluorescent and fluorescent states is central to every super-resolution fluorescence microscopy (optical nanoscopy) technique, and the exploration of radically new switching mechanisms remains critical to boosting the performance of established, as well as emerging super-resolution methods. Photoactivatable dyes offer significant improvements to many of these techniques, but often rely on photolabile protecting groups that limit their applications. In this presentation, I will describe a general method to transform 3,6-diaminoxanthones into caging-group free photoactivatable fluorophores that operate on a light-promoted radical reaction. These photoactivatable xanthone (PaX) dyes can be prepared from readily available starting materials to yield a family of fluorophores spanning the entire visible spectrum. This molecular design can be further extended to build photoactivatable fluorophores with large Stokes shift emission, and probes for bioorthogonal click chemistry. I will showcase the utility and versatility of these new dyes and labels in optical microscopy and nanoscopy techniques including STED (stimulated emission depletion), PALM (photo-activated localization microscopy), and MINFLUX (minimal photon fluxes).

Advancing Porphyin-Phospholipid Technology

Jonathan F. Lovell

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Porphyrin-phospholipid (PoP) conjugates can stably incorporate into liposomes, opening possibilities for light-triggered drug delivery to solid tumors, termed chemophototherapy (CPT). Although CPT represents a novel and potent ablative modality, significant barriers exist for using PoP first-in-human testing and commercialization. We will describe our attempts to advance PoP technologies for CPT, as well our experience in pivoting the technology to advance PoP materials as vaccine candidates through IND-enabling studies and clinical testing for a range of infectious disease indications.

Synthesis and Characterization of Light-Triggered Metal Complexes for Cancer Treatment

Dalton Lucas, Alisher Talgatov, Broderick Nelson, Ge Shi, Gurleen Kaur, Debby Sunday, Abbas Vali, Colin G. Cameron, Sherri A. McFarland

University of Texas at Arlington

Photodynamic therapy (PDT) is a clinically approved, minimally invasive treatment modality that uses light activation of a photosensitizer (PS) in the presence of oxygen to generate reactive oxygen species (ROS). These ROS selectively destroy tumor cells and vasculature while sparing healthy tissue and can also stimulate antitumor immune responses. PDT can be used as a standalone treatment or in combination with conventional therapies, particularly when resistance limits their efficacy. In recent years, transition metal complexes, especially those derived from ruthenium (Ru), have garnered significant attention as next-generation PSs due to their tunable photophysical and redox properties. Our lead compound, TLD1433—a Ru(II) tris-diimine complex bearing an imidazo-phenanthroline-terthienyl moiety—has advanced to phase II clinical trials for the treatment of non-muscle invasive bladder cancer. Building on this framework, we have developed a new class of Ru(II) polypyridyl complexes featuring oligothiophene substituents. Here, we systematically examine how varying the number of thienyl groups influences the chemical stability, photophysical characteristics, and biological activity of these complexes to identify structure–function relationships relevant to improved PDT agents.

Harnessing Nature and Light: Identifying Photoactive Compounds for Next-Generation Acne Treatments

Kim Luu

Department of Chemistry and Biochemistry

Antimicrobial resistance (AMR)—the ability of microorganisms such as bacteria to survive antibiotic treatment—is a growing global health crisis driven by the overuse and misuse of antibiotics. This project will investigate plant-derived natural products from easily sourced species in North Texas as potential photosensitizers (PSs) for antimicrobial photodynamic therapy (aPDT), a light-based approach that can destroy drug-resistant pathogens without promoting resistance. When exposed to visible light, PSs generate reactive oxygen species that rapidly and nonspecifically damage microbial cells. The objectives of this study are to extract and characterize light-responsive natural products, including emodin-like compounds, and to evaluate their antimicrobial and photo-enhanced activity against Staphylococcus aureus, a bacterium commonly associated with resistant infections. Promising candidates will be identified for development into low-cost, deployable treatments that could be used in field or community settings for the effective control of localized infections or to prevent such infections from developing. It is hypothesized that these plant extracts will exhibit strong photoactivated antibacterial activity with minimal dark toxicity, providing a safe and affordable means to combat AMR. This work aims to expand understanding of natural product chemistry and support the design of sustainable, accessible technologies that protect global health.

Towards Photoacoustic Imaging-Enabled Personalized Photodynamic Therapy: From Molecular Contrast to Real-time Oxygen Mapping

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Photodynamic therapy (PDT) is a clinically established, minimally invasive cancer treatment whose efficacy critically depends on photosensitizer distribution, light delivery, and, most importantly, the availability and dynamics of oxygen within the tumor microenvironment. However, the lack of robust, real-time dosimetry tools has limited the ability to personalize PDT and adapt treatment on the fly. Photoacoustic imaging (PAI), which combines optical contrast with ultrasound resolution and depth penetration, offers a unique opportunity to address this unmet need by enabling quantitative, spatially resolved monitoring of molecular agents and tumor physiology during therapy.

In this talk, we highlight how PAI can be leveraged as a powerful platform for personalized PDT dosimetry by integrating insights across molecular contrast mechanisms, oxygen dynamics, and advanced signal processing. First, we demonstrate that clinically relevant fluorophores and photosensitizers, such as IRDye800 conjugated to targeting antibodies, can serve as effective PA contrast agents. Importantly, PA signal exhibits distinct temporal dynamics compared to fluorescence, driven by aggregation state and intracellular processing, providing mechanistic insight into molecular binding, internalization, and degradation—parameters directly relevant to PDT timing. Second, we show that ultrasound-guided PAI enables real-time, spatially resolved monitoring of blood oxygen saturation (StO_2) during PDT, revealing heterogeneous oxygen consumption, fluence-rate–dependent hypoxia, and regions of reoxygenation that correlate with vascular function and long-term treatment response. Third, we discuss strategies to overcome practical limitations in molecular PA imaging, including photobleaching, using generative deep learning approaches that enable high-SNR, single-pulse imaging suitable for real-time clinical workflows. Finally, we present theranostic oxygen-carrying nanodroplets that synergistically enhance PDT efficacy while allowing direct PA monitoring of oxygen delivery and treatment response.

Collectively, these advances position photoacoustic imaging as a comprehensive, real-time dosimetry tool capable of informing PDT dose design, optimizing treatment timing, and enabling truly patient-specific photodynamic therapy.

π-Extended Ru-COUBPY complexes as potent photosensitizers for in vivo anticancer phototherapy using one-photon NIR light

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Photodynamic therapy (PDT) is a non-invasive cancer treatment that allows precise spatiotemporal control of drug activation using light. However, most clinically approved photosensitizers (PSs) exhibit poor activation in the deep-red and near-infrared (NIR) region, which limits their efficacy against large, hypoxic tumors due to oxygen dependence and shallow light penetration. To address these limitations, we have developed a novel family of highly potent PSs based on Ru(II) polypyridyl complexes incorporating coumarin-derived COUBPY ligands, demonstrating outstanding in vitro and in vivo PDT performance under irradiation within the phototherapeutic window. Here, we present Ru-COUBPY complexes featuring π-extended COUBPY ligands, designed through a vinylogation strategy and assembled via

a post-coordination approach. These structural modifications significantly enhance molar absorptivity and red-shift absorption bands into the NIR region without compromising photostability. The new π-extended Ru-COUBPY PSs exhibit strong in vitro phototoxicity against cancer cells under deep-red and NIR irradiation, even under hypoxic conditions, representing a significant improvement over the parent complexes. Remarkably, Ru6, the lead compound, achieved strong in vivo tumor growth inhibition in mice bearing subcutaneous colorectal tumors upon irradiation with highly-penetrating one-photon NIR light at 780 nm. This constitutes one of the first examples of Ru(II) polypyridyl complexes displaying potent antitumor activity under one-photon NIR activation. The broad activation profile and high phototoxicity of this Ru-COUBPY complex underscore its potential for treating deep-seated, oxygen-deficient tumors, marking a promising step toward next-generation PSs for clinical translation.

UV Excitation of Uracil Results in the Formation of a Ground-State Intermediate in Less Than One Picosecond and Its Decay is Quenched by Nucleophilic Water Addition

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Case Western Reserve University

Investigating the excited-state dynamics of RNA is essential for understanding potential damage to biological systems, developing new biotechnologies, and gaining fundamental insights into molecular behavior and the chemical evolution of life on Earth. In this study, we investigate the excited-state dynamics of uracil after excitation at 267 nm in both aqueous and deuterated phosphate buffered solutions. We employ broadband transient absorption with femtosecond time resolution, complemented by steady-state absorption spectroscopy and quantum-chemical calculations. The primary focus is on detecting and investigating the reactivity toward water addition of a recently predicted reaction intermediate, which may lead to the formation of 6-hydroxy-5,6dihydrouracil photohydrates. We support the experimentally determined transient absorption spectrum of this intermediate with the simulated absorption spectrum obtained through quantum-chemical calculations, which accounted for both explicit and implicit solvent effects. This comparison confirms that the transient species can be identified as a ground-state half-chair twisted uracil intermediate. The intermediate is formed in less than 1 ps from the decay of the $1\pi\pi^*$ excited state. Additionally, its decay is driven by the nucleophilic addition of a water molecule, which occurs with lifetimes of 22.7 ± 0.2 ps in aqueous solutions and 30.8 ± 0.3 ps in deuterated water solutions. All things considered, the results presented in this study and elsewhere demonstrate that this reaction intermediate is the precursor of the 6-hydroxy-5,6-dihydrouracil photohydrates.

The Tortoise and the Hare in Photodynamic therapy: How to deliver painless PDT

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Since the clinical introduction of photodynamic therapy (PDT) in the late 1990's as a field treatment for widespread actinic keratoses (AKs), a major problem for many patients has been the stinging pain that they experience during illumination with blue light when it is done according to the FDA-approved protocol which calls for a long incubation time with the photosensitizer (5-ALA), specifically for 16-18 hr prior to illumination. PDT using shorter incubation times of 1-3 hr is more tolerable, yet unpleasant pain can often still occur. In the last decade, protocols using daylight or low-fluence light sources coupled with a short drug incubation time have been increasingly shown to provide surprisingly good lesion clearance results. In this talk, mechanisms responsible for the good therapeutic e[icacy observed in the absence of concentrated photosensitize levels will be discussed. Those mechanisms include selective mitochondrial targeting and the preferential activation of anti-tumor immunity, as opposed to direct PDT-induced apoptosis or vascular destruction. From a clinical standpoint, the availability of pain-free yet e[ective protocols makes PDT therapy more successful overall, because patients are no longer afraid to undergo the treatment and willingly agree to return for multiple PDT sessions. Ongoing work in this area has led to development of protocols in which ALA is coupled with blue light, red light, metered daylight, or low-intensity light fabrics. Studies describing these new PDT protocols will be reviewed.

The rare single chromophore dual-release photochemistry of sulfoximines and sulfone diimines

Ryan D. McCulla

Saint Louis University

Generating two distinct reactive intermediates from a single chromophore is a rare phenomenon in photochemistry. A notable example is the photolysis of dibenzothiophene sulfoximines, which produces both nitrenes and atomic oxygen upon irradiation. This dual release creates localized oxidative stress while simultaneously labeling nearby biomolecules, offering a powerful strategy for studying oxidative stress in cells.

To investigate this reactivity, we analyzed several N-aryl dibenzothiophene sulfoximines using product studies, photophysical measurements, and quantum yield determinations. We found that the electron demand of the N-aryl substituents strongly influenced the quantum yield: electron-withdrawing groups promoted dibenzothiophene S-oxide formation, whereas electron-donating groups reduced it. These results demonstrate that tuning the N-substituents provides an effective means of controlling nitrene production in dibenzothiophene sulfoximines.

Sulfondiimines, a related class of organosulfur(VI) compounds and diaza sulfone analogues, have recently gained attention in medicinal chemistry and drug discovery. Despite their pharmacological promise, their photochemistry has been largely unexplored. Given their structure, sulfondiimines may display unique reactivity, potentially enabling the generation of two distinct short-lived nitrenes and opening new synthetic pathways. To probe these possibilities, we are currently investigating the dual-release photochemistry of diaryl sulfondiimines and developing predictive models for their reactive intermediates.

From Foundations to Frontiers in Photobiology: Molecules to Medicine with Photoactive Metal Complexes

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Light-driven processes lie at the heart of photobiology, offering unique opportunities to probe, modulate, and treat biological systems with exceptional precision. Metal complexes, with their rich excited-state landscapes and modular photophysical design, have emerged as transformative tools across this continuum—from fundamental mechanistic discovery to translational photomedicine. This lecture will highlight how coordination chemistry, photophysics, and cellular photobiology converge to create next-generation photoactive therapeutics capable of highly selective biological responses.

Drawing on advances that enabled the first ruthenium-based photosensitizer, TLD1433, to progress into clinical trials, I will trace a molecules-to-medicine trajectory that illustrates how foundational research in excited-state dynamics, ligand design, and photochemical control shaped new therapeutic modalities in oncology and infectious disease. These examples reveal how metal complexes can expand the conceptual and practical frontiers of

photodynamic therapy and inspire broader innovation in light-activated therapeutics.

Reflecting the ASP 2026 theme From Foundations to Frontiers in Photobiology, this Presidential Lecture will emphasize the field's integrative nature—where chemistry, biology, medicine, and technology intersect—and how the ASP community is uniquely positioned to lead the next era of discovery and impact.

From Femtoseconds to Function: Integrative Spectroscopy to develop novel fast red reversible photoswitchable fluorescent proteins.

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In recent years, reversible switchable fluorescent proteins (RSFPs) have gained attention due to their ability to undergo a reversible, photo-induced transition using two different lights between a fluorescent (On) state and a non-fluorescent (Off) state. The development of novel RSFPs that work in the red/NIR domain is one of recent challenges in nanoscopy as this domain is highly advantageous for live-cell imaging due to its reduced phototoxicity, lower autofluorescence, greater penetration depth in vivo, and expanded spectral multiplexing capabilities. Another key challenge is also the need for fast RSFPs with millisecond thermal back recovery of the Off/On state, such RSFPs enable super-resolved imaging with only one light and This unique novel system provides a promising template for the development of useful red-sensitive fast photoswitches for nanoscopy and/or optogenetic applications.

Here, we present the development of fast red RSFPs based on (i) a derivative of the wild-type bacteriophytochrome from Deinococcus radiodurans and (ii) a charge-transfer complex composed of a flavin cofactor and a substrate-analogue inhibitor from the monomeric sarcosine oxidase flavoprotein family. To characterise key intermediates that govern switching quantum yield and thermal back recovery we investigated their photodynamics from femtosecond to minute time scale integrating the results of different time resolved spectroscopy and a unique instrument that allows multi-timescale transient absorption experiments. This approach allowed us to reveal nanosecond-scale dynamics with unprecedented accuracy. We will discuss our findings and their implications for the design of novel red/NIR RSFPs optimized for nanoscopy applications.

Photostability of therapeutic mAbs and ADCs under real-life light doses

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Monoclonal antibodies (mAbs) and antibody–drug conjugates (ADCs) represent a rapidly expanding class of biopharmaceuticals that have revolutionised cancer therapy due to their high specificity and reduced toxicity compared with conventional chemotherapies. However, these molecules are inherently susceptible to chemical and physical instability, which may compromise their efficacy and safety throughout their real-life lifecycle.

This study aimed to evaluate the physicochemical stability and biological activity of selected mAbs and ADCs following exposure to light doses mimicking real-life conditions during preparation and administration. The mechanisms underlying the observed modifications were also investigated to elucidate their impact on target recognition. Different formulations of mAbs and ADCs, at clinically relevant concentrations and in saline or glucose solutions, were exposed to indoor light to simulate hospital conditions.

While mAbs preserved their overall conformational integrity, they exhibited increased aggregation and reduced target-binding capability. In contrast, ADC solutions showed visible colour changes and spectroscopic evidence of payload alteration, without detectable protein aggregation. Notably, although the cytotoxic payload and linker appeared to hinder aggregation, the presence of an additional photosensitive moiety represents an increased risk of instability.

Overall, these findings highlight the critical role of diluent composition, light exposure, and handling procedures in preserving the stability and therapeutic efficacy of mAbs and ADCs, while also revealing drug-specific differences in light-induced behaviour.

Chemiexcitation of melatonin promotes lutein degradation in retinal environments

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In the retinal pigment epithelium, melatonin, a neurohormone synthesized by photoreceptors, is exposed to persistent oxidative stress and can undergo chemiexcitation during oxidation, generating electronically excited intermediates; however, how this excitation energy propagates to surrounding molecular targets remains unknown. In this study, lutein was employed as a molecular probe to investigate whether triplet excited-state species formed during melatonin oxidation can induce downstream oxidative reactions. Triplet-excited melatonin-derived intermediates were generated in vitro by incubating melatonin with HRP/H_2O_2, a reaction previously shown to proceed through dioxetane-mediated chemiexcitation and the resulting species were exposed to lutein. Because lutein undergoes thermal degradation, lutein loss under melatonin oxidation conditions was compared with thermally treated lutein controls and a reference singlet oxygen system generated by rose Bengal photosensitization. Quadrupole time-of-flight mass spectrometric (QTOF-MS) analysis revealed a time-dependent decrease in lutein signal accompanied by the formation of multiple degradation products. Lutein loss exceeded that observed under thermal conditions alone, indicating a non-thermal contribution to degradation, and the degradation profile differed from that produced by singlet oxygen photosensitization, suggesting that triplet-associated excited-state pathways predominate under these conditions. Collectively, these findings provide evidence that chemiexcitation during melatonin oxidation can drive oxidative transformations of nearby substrates through excited-state interactions and support condition-dependent propagation of excited-state chemistry in retinal environments. Ongoing studies are aimed at extending this mechanistic framework to known components of lipofuscin, an age-related pigment that accumulates in the retina and contributes to retinal inflammation, with the long-term goal of identifying pathways with potential therapeutic relevance.

Artificial Photosynthetic Systems

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Early on, we designed artificial photosynthetic reaction centers with antennas and built in photoprotection. Later, these systems were used to explore the generation of PMF and ATP in artificial energy-coupling membranes. Recently, inspired by proton-coupled electron transfer (PCET) in photosystem II involving Tyrz-His190, a benzimidazole-phenol (BIP) system illustrated electrochemical one-electron oxidation of the phenol, accompanied by proton translocation to the benzimidazole (E1PT process). Long-range proton translocation in constructs consisting of a phenol, a Grotthuss-type hydrogen-bonded network based on polybenzimidazoles, and a terminal proton acceptor (TPA) was used to demonstrate the translocation of protons up to ~16 Å (E4PT process). A photochemical E1PT process was studied with BIP linked to tripentafluorophenylporphyrin. Two-dimensional electronic-vibrational spectroscopy (2DEV) shows that PCET occurs via an ultrafast, concerted process from the unrelaxed S1 state on the femtosecond time scale. By adding a pyridine derivative TPA to form a Grotthuss-type proton wire, the dynamics of a photoinduced E2PT process were explored. Following porphyrin excitation, proton arrival to the TPA and electron arrival to the porphyrin are concerted (up to an uncertainty of 24 fs). Currently, we are experimenting with PCET in protein environments. Constructs consisting of a four-helix bundle enclosing a Mn-porphyrin with a covalently attached BIP docked to a high-potential bacterial reaction center (BRC) have been assembled. Exciting the BRC reversibly oxidizes Mn(II)-Porphyin to Mn(III)-Porphyrin, which electrostatically drives a proton into the solution. This models the ubiquitous electrostatics in PCET processes in bioenergetics and opens the way to hybrid constructs where energy-conserving processes could be reengineered.

Reflectin: a protein machine dynamically fine-tuning the color of squid skin for camouflage and communication

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We discovered the mechanism by which reflectin acts as a protein machine, driving an osmotic motor that changes the refractive index, thickness and spacing of subcellular Bragg reflectors in squid skin to dynamically fine-tune the structural color and intensity of reflected light for camouflage and communication. These changes in iridescence are initiated by a neurotransmitter-activated signal transduction cascade that culminates in enzymatic phosphorylation of reflectin proteins, the major constituents of the membrane-bounded Bragg lamellae. The resulting neutralization of the cationic reflectins acts as a molecular switch, overcoming their Coulombic repulsion and allowing their reversible folding and hierarchical assembly. Sequence analysis shows the reflectins to be block copolymers with repeated canonical domains interspersed with cationic linkers. Biophysical analyses of the purified recombinant reflectins in conjunction with quantitative molecular modeling reveal that neutralization-driven condensation triggers secondary folding of the canonical repeats to form amphiphilic, bifacially phase-segregated beta structures, with the emergence of hydrophobic faces that act like molecular Velcro to mediate hierarchical assembly. This assembly triggers the osmotic and Gibbs-Donnan expulsion of water, shrinking the thickness and spacing of the Bragg lamellae while simultaneously increasing their refractive index. The result is a progressive, precisely calibrated change of color of the reflected light across the visible spectrum, with a sharp increase in the intensity of reflectance. The process is reversible, cyclable and finely tunable, allowing selective reflection of any color. We now are using low voltage as a surrogate for phosphorylation to dynamically reconfigure reflectin-based nanostructures in new approaches for tunable photonic systems.

Cyclic AMP Response Element-Binding Protein (CREB) as a novel biomarker for evaluating photoprotection of photoprotective agents in attenuating skin carcinogenesis

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Despite ongoing sun safety campaigns, Australia and New Zealand have the highest skin cancer rates globally. This indicates a critical need to further enhance photoprotective interventions. Previous studies from our group have identified that biologically active vitamin D, 1,25-dihydroxyvitamin D3 (1,25D), and structurally related compounds such as 1,25-dihydroxylumisterol (JN) and tetrahydrocurcumin (THC) are novel photoprotective agents. The ability of an agent to reduce acute ultraviolet radiation (UVR)-induced damage, in the form of DNA damage and immunosuppression, has traditionally been used to predict its ability to successfully reduce chronic UVR-induced damage in a 40-week murine photocarcinogenesis model. However, several compounds that were tested, including 20-hydroxyvitamin D (20D) and 1α-hydroxymethyl-16-ene-24,24-difluoro-25-hydroxy-26,27-bis-homovitaminD3 (QW), demonstrated that this correlation is not consistently reliable. To overcome this limitation, biomarkers such as phosphorylated cyclic AMP- regulatory element binding protein (pCREB), may serve as a predictive biomarker in evaluating an agent's photoprotective ability. pCREB is an overexpressed transcription factor in skin cancer. We have demonstrated that UVR increases pCREB levels in primary human skin cells and that 1,25D can reduce pCREB levels. We now show in this primary human skin cell model in vitro, as well as in in vivo murine and ex vivo human skin models, that photoprotective compounds capable of reducing skin tumours in chronic models significantly reduce UVR-induced pCREB, whereas non protective compounds do not alter pCREB levels. These findings support the potential for pCREB as a predictive biomarker of for identifying more eaective photoprotective agents.

Design and Evaluation of Photoactive Metallodrugs for Cancer Therapy

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The University of Texas at Arlington

Photodynamic therapy (PDT) is an alternative cancer treatment that offers high spatial selectivity through the use of light activation. PDT employs a light-activated drug, or photosensitizer (PS), which in the presence of molecular oxygen generates reactive molecular species (RMS) that induce localized cell death. Clinically approved PSs are typically organic tetrapyrroles that mediate cytotoxicity via singlet oxygen and other reactive oxygen species (ROS). Transition metal complexes have emerged as promising alternatives due to their tunable excited-state properties and diverse photochemical mechanisms. Our own ruthenium(II)-based complex, TLD1433 (Ruvidar®), is currently in Phase II clinical trials for non–muscle-invasive bladder cancer (NMIBC). In this work, we describe the design, synthesis, and characterization of new metal-based complexes structurally analogous to TLD1433 that display potent phototoxicity

upon light irradiation. Systematic modification of these complexes enables fine-tuning of their photophysical and photobiological properties, offering insights into the structure–activity relationships governing photoactivated cancer therapeutics.

Clustering-triggered photoantimicrobials

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Photodynamic therapy has emerged as a promising alternative to antibiotics against the antimicrobial resistance threat. However, traditional photosensitizers suRer from aggregation-induced quenching, limiting ROS production. Aggregation-Induced Emission (AIE) materials, or AIEgens, overcome this by enhancing emissive and photosensitizing properties upon aggregation, though their conjugated structures raise concerns about stability and biocompatibility.

An alternative mechanism, Clustering-Triggered Emission (CTE), arises from aggregation of heteroatoms and unsaturated bonds, forming light-absorbing and light-emitting clusters through intramolecular electron interactions. A novel type of materials thus emerged that disrupt conventional luminescence paradigms. We have recently shown that CTE materials (CTEgens) can also generate ROS and show strong photoantimicrobial activity against Staphylococcus aureus while remaining non-toxic without light. We will provide a number of examples of clustering-triggered photoantimicrobial activity exhibited by materials of natural origen. Our findings establish CTEgens as novel, viable photosensitizers for antimicrobial photodynamic therapy.

Perylenequinones: fungal metabolites under the spotlight

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Fungal metabolites are well known for providing humanity with medical benefits, with penicillin and the antibiotics revolution that it stimulated probably one of the greatest examples. Interestingly, some of these molecules display a high level of conjugation, and as such, can be considered redox active metabolites (i.e., RAMs). With a diverse group of collaborators, we have been studying ways to harness the redox properties of fungal perylenequinones, specifically hypocrellins [i.e., ent-shiraiachrome A] and hypomycins [i.e., hypomycin C], towards applications in photodynamic therapy. This talk will present our understanding of these molecules, ranging from fermentation optimization studies to semisynthesis of bioactive leads to harnessing their redox potential in a variety of applications. Additionally, it will give some background into the tools and strategies used in the discovery of bioactive compounds from fungi.

A 3D-printed bubble perfusion platform for time-resolved calcium imaging in ex vivo brain slices

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Understanding how neural tissues dynamically respond to chemical and environmental cues, including those relevant to circadian rhythm regulation, requires experimental platforms that provide precise spatiotemporal control while maintaining tissue viability. We developed a 3D-printed microfluidic perfusion system for ex vivo brain slice culture that delivers alternating oxygen bubbles and media or media-drug droplets ("bubble perfusion"), enabling single-droplet delivery with optical access for fluorescence imaging. The device integrates on-chip thermal management and droplet prewarming to maintain physiological temperatures with minimal intradroplet temperature drift during stimulation. Mouse brain slices containing the suprachiasmatic nucleus (SCN), the central circadian pacemaker, were maintained under on-demand oxygen and media perfusion for up to 12 h, and neural activity was assessed by fluorescence imaging of intracellular Ca^{2+} dynamics. Robust Ca^{2+} responses were observed following single-droplet delivery of depolarizing (60 mM KCl) and pharmacological stimuli. Sequential droplet analysis resolved minute-scale temporal dynamics of Ca^{2+} signaling and recovery. Tissue viability after extended perfusion was confirmed using end-point propidium iodide staining. To demonstrate the utility of the platform for probing receptor-mediated signaling relevant to circadian physiology, Ca^{2+} responses induced by the cannabinoid ligands anandamide and cannabidiol were compared in SCN tissue. Despite diZering proposed mechanisms of action, both ligands produced Ca^{2+} transients with similar magnitudes and temporal profiles, highlighting the sensitivity of the system for detecting modest physiological responses. This work establishes an open-access, 3D-printed perfusion platform that enables time-resolved optical interrogation of living brain tissue and supports photobiological studies of neural signaling, circadian rhythm regulation, and pharmacological modulation.

Photochemical Targeting of the Ovarian Cancer Lipidome: Docosahexaenoic Acid Sensitizes Ovarian Cancer Cells to Photodynamic Priming and Ferroptosis

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High-grade serous ovarian carcinoma (HGSOC) remains a significant clinical burden, often characterized by metastatic, non-resectable disease and high rates of resistance to standard-of-care platinum chemotherapy. Lipidomic reprogramming—specifically alterations in phospholipid saturation and the sphingolipid rheostat—has emerged as a key driver of chemoresistance by facilitating the evasion of regulated cell death pathways, including apoptosis and ferroptosis (death by lipid peroxidation).

Photodynamic priming (PDP) is an emerging strategy to sensitize residual disease to chemotherapy via localized photochemical generation of reactive molecular species. While PDP operates through various mechanisms, our recent work demonstrates that benzoporphyrin derivative (BPD)-enabled PDP induces distinct lipidomic rearrangements defined by the cell's underlying lipid composition. In ferroptosis-sensitive OVCAR-3 cells enriched in polyunsaturated phospholipids, PDP triggered both lipid peroxidation and apoptosis-driving ceramide upregulation. Conversely, in ferroptosis-resistant Caov-3 cells, PDP primarily induced

ceramide upregulation coinciding with caspase 3/7 activation.

Here, we investigated supplementation with docosahexaenoic acid (DHA), an oxidation-sensitive polyunsaturated fatty acid found in fish oil, as a means of enhancing PDP efficacy by modulating lipid states. While DHA did not alter PDP efficacy in ferroptosis-sensitive OVCAR-3 cells, it significantly sensitized ferroptosis-resistant Caov-3 cells to both pharmacological ferroptosis and PDP. Mechanistically, we hypothesize that DHA increases membrane unsaturation, thereby amplifying the lipid peroxidation that occurs downstream of photochemical activation. In summary, we demonstrate that PDP induces context-dependent lipidomic changes and that DHA effectively sensitizes Caov-3 cells to both pharmacological ferroptosis and PDP, offering a novel approach to targeting lipid-driven treatment resistance in HGSOC.

Protic ruthenium anticancer compounds: Describing the role of ligand charge in both photodissociation and singlet oxygen production

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Abstract: Ruthenium (Ru) complexes with anticancer properties are a growing area of research with increasing promise since several Ru compounds have entered clinical trials, but few Ru anticancer compounds have been protic. The advantage of protic Ru compounds lies in the ability to perform fundamental studies to correlate structure with function. Removal of protons from a protic Ru complex represents an electronic change with minimal steric change. Therefore, it is interesting to investigate how proton removal impacts the photochemical properties of protic Ru complexes. We have designed several new complexes based upon the [(N,N) Ru(n,n′-dhbp)] scaffold where (N,N) is a bidentate diimine ligand and n = 4 or 6 in n,n′-dhbp (dihydroxybipyridine). When treated with visible light, these complexes can photodissociate to eject a ligand or they can react with air to generate singlet oxygen, with the extent to which each pathway dominates varying from compound to compound. In our studies, the protonation state of the ligand influences the photochemical pathway that dominates. We describe how these pathways and how cellular uptake and subcellular localization together leads to the resultant photocytotoxicity of the compounds. Several of the compounds described are light activated with our best compound achieving sub micromolar EC50 values with phototoxicity indices as high as ~100 vs. breast cancer or melanoma cells. New directions for our group will also be discussed.

Molecular and biological mechanism studies of protein photooxidation to control cell fate and their therapeutic applications

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This abstract includes three published works.

Reactive oxygen species (ROS) are increasingly recognized not only as damaging agents but also as modulators of cell fate, depending on their localization, dosage, and timing. This work explores how protein photooxidation, when spatially and chemically controlled, can be used to direct therapeutic outcomes in cancer and immune regulation.

We develop neutral Ir(III)-based photosensitizers that localize to lysosomes and generate ROS under light exposure. The targeted lysosomal oxidation inhibits autophagy, a critical resistance mechanism in cancer cells. The approach sensitized drug-resistant cells in vitro and in vivo, offering a promising strategy to overcome therapeutic resistance via photoinduced autophagy disruption. We also introduce an amphiphilic photocatalyst that overcomes hypoxia—a major challenge in photodynamic therapy—by oxidizing intracellular water to H_2O_2, which forms hydroxyl radicals (•OH) via electron transfer. The process is enhanced under hypoxic conditions and induces non-canonical pyroptosis by oxidizing membrane proteins, triggering inflammasome activation and gasdermin D-mediated cell death. This highlights the immunogenic potential of controlled protein oxidation. Lastly, we uncover a novel oxidation mechanism occurring within folded protein cores. Through "O_2-confinement oxidation," molecular oxygen trapped in hydrophobic pockets reacts with photoexcited tryptophan to generate ROS, leading to structural collapse. Proteomics revealed this mechanism affects a broad set of cellular proteins, linking it to stress and degradation pathways.

These studies demonstrate that protein oxidation can be finely tuned to control subcellular processes and cell death pathways. Strategic design of photosensitizers enables therapeutic precision and opens new directions for treating resistant cancers and inducing immunogenic responses.

Synthesis and Photochemical Evaluation of Benzonaphthothiophene N-Phenyl Sulfoximines for Controlled Release of Atomic Oxygen and Nitrene Species

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The Bolm–McCulla reaction provides a solution-phase pathway for the controlled photochemical generation of ground-state atomic oxygen ($O(^3P)$) through photoinduced deoxygenation of sulfur heterocycles such as dibenzothiophene S-oxides. Unlike other reactive oxygen species, $O(^3P)$ displays comparatively selective reactivity, enabling targeted oxidation of sulfides, thiols, and unsaturated substrates under mild conditions. Sulfoximines, which contain both S–O and S–N bonds, offer an expanded photochemical platform capable of releasing either atomic oxygen or nitrene intermediates from a single chromophore; however, prior studies indicate that nitrene release is kinetically favored. This work aims to structurally bias sulfoximine photochemistry toward preferential $O(^3P)$ generation by expanding and electronically tuning the dibenzothiophene chromophore. Herein, we report the design, synthesis, and photochemical evaluation of a series of benz[o]naphthothiophene (BNT) and dinaphthothiophene (DNT)-based sulfoximines. Efficient synthetic routes were developed using Suzuki cross-coupling, Seyferth–Gilbert homologation, and platinum-catalyzed alkyne cyclization to access extended sulfur heterocycles with improved selectivity. Subsequent oxidation and N-functionalization furnished a library of N-phenyl sulfoximines bearing electron-donating and electron-withdrawing substituents. Quantitative photolysis was conducted on our BNT/DNT sulfoximines to determine quantum yield. Photochemical kinetics were evaluated. Nitrene trapping experiments were conducted to identify photolysis products. These studies establish a structure–activity framework connecting chromophore expansion and electronic effects to photochemical pathway selection, laying the foundation for rational design of sulfoximine-based photooxygen donors with tunable atomic oxygen release.

Light-directed click strategies for permanent or reversible derivatization of biological substrates

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Photochemical triggering of "click" reactions permits the spatial and temporal control of the derivatization, labelling, cross-linking and patterning of various substrates. The absence

of potentially detrimental catalysts and/or activating reagents is another beneficial feature of this approach. We will present three photo-click strategies that have been developed in our laboratory. "Photo-SPAAC" click ligation is based on light-triggered release of azide-reactive cyclooctynes from cyclopropenone – caged precursors. This method allows for the coupling of the high selectivity and fast rate (up to 840 M-1s-1) of the SPAAC reaction with spatiotemporal control. "Photo-IEDDA" technique relies on a selective and very rapid cycloaddition (~4x104 M-1s-1) of photogenerated o-naphthoquinone methides (NQMs) to electron-rich alkenes producing photostable benzochroman derivatives. "Photo-Michael" reaction allows for selective and reversible modification of thiol groups in biological or synthetic polymers, as well as write-erase-write processes on the thiolated surfaces. This method makes use of a very facile reaction (>2x105 M-1s-1) between NQMs and thiols to give hydrolytically stable thioether. In the absence of NQMP, thioether linker can be photochemically cleaved to regenerate the substrate. "Photo-Michael" ligation resembles well-known thiol-ene strategy, but does not involve the formation of free radicals.

Melanin as a Redox Hub: From Light Absorption to Dark-Phase Photochemistry

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Chemiexcitation, first identified in mammals through our work, revealed that melanin can generate electronically excited states and delayed cyclobutane pyrimidine dimers (dCPDs) long after illumination ends. Using tunable pigmentation systems, we now demonstrate that melanin itself, rather than active melanogenesis, is the essential determinant of this dark-phase photochemistry. Re-pigmenting tyrosinase-deficient melanocytes with DHICA/DHI monomers restored delayed CPDs, and oxidative stress alone re-initiated chemiexcitation in both pigmented and pigment-deficient cells, establishing pigment presence plus oxidative load as the minimal requirements for post-irradiation excitation chemistry. We further show that intracellular melanin directly activates nitric oxide synthase (NOS), producing reactive nitrogen species that re-oxidize pigment and sustain a self-amplifying pigment-NOS-chemiexcitation loop. Nitrotyrosine accumulation closely tracks with melanin load, and NOS inhibition abolishes delayed CPDs even when pigment remains present, indicating that melanin-driven NOS signaling is required for dark-phase DNA damage. To assess disease relevance, we analyzed institutional and public melanoma datasets. Melanomas endogenously exhibit high NOS activity, and tumors with elevated pigment-pathway markers (TYR, DCT, MITF) form a subgroup with significantly poorer survival, reduced effector T- and B-cell infiltration, and enrichment of immunosuppressive microenvironments. This convergence of high melanin load + high NOS signaling mirrors our mechanistic findings and suggests that melanoma retains a redox architecture capable of sustaining chemiexcitation-like chemistry, potentially contributing to oxidative stress programs, immune exclusion, and adverse clinical outcomes, even when tumors appear clinically amelanotic. Together, our results position melanin as a photochemically active redox hub which governs dark-phase reactivity in skin and influences melanoma biology.

Preliminary results on PDT as an alternative treatment for Alzheimer's disease using organic dyes to inhibit the tau protein aggregation

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Alzheimer's disease (AD), which affects more than 40,000 Panamanians, has two causes: β-amyloid (Aβ) deposits that form senile plaques, and the formation of tau protein microtubule aggregates in neuronal cells (tautopathy). This research seeks to study a mechanism for inhibiting tauopathy using photodynamic therapy (PDT) with organic dyes as photosensitizers that, when irradiated, generate reactive oxygen species (ROS) capable of mitigating tauopathy, ranking them based on their efficacy for an alternative treatment of AD.

The inhibition of tauopathy by PDT has been studied with the organic dyes Rose Bengal (RB) and Toluidine Blue (TB), determining the optimal concentration of the photosensitizer and the wavelength at which it should be irradiated to obtain a greater inhibitory effect, as well as its biocompatibility with neuronal cells.

This research draws on studies with RB and TB and seeks to apply them to 5-aminolevulinic acid (5-ALA), methylene blue (MB), curcumin (CUR), coumarin, Congo red FSB (CR-FSB), and the double demethylated derivative of toluidine blue O (dd-TBO) developed in Panama, to determine and quantify their tauopathy inhibition potency, comparing the percentage of tau protein that forms aggregates when incubated in the presence and absence of each species and when irradiated at different wavelengths. In turn, the biocompatibility of each photosensitizer in neuronal cells will be determined through cytotoxicity assays.

Ruthenium photocaged CHIR99021 for robust stem cell differentiation

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Stem cell differentiation is a complex process of carefully orchestrated lineage commitments, assisted in vitro with the addition of important small molecule inhibitors (SMIs) and growth factors doped into media. Recent work has demonstrated that precise, timely addition (within 10-15min of the timepoint) of these soluble factors is necessary for high-fidelity differentiation of mature cells. This requires labor and time sensitive differentiation protocols, hindering the robust and reproducible manufacturing of SCs, and necessitating optimization of the differentiation process to advance their clinical application. Here we show photo-actuated, temporally controlled uncaging of a common Wnt-pathway activator CHIR99021 using ruthenium-based photocages. Two photocages were tested with varying hydrophilic components to ensure cytocompatibility. Our results indicate that ruthenium photocaged CHIR99021 can be effectively released in cell culture at high yields with low cytotoxicity. In various reporter cell lines and assays we observe a significant enhancement in CHIR99021 activity between pre- and post-light exposure matching free CHIR99021, indicating excellent caging efficiency with minimal adverse impacts by the Ru-based cage. CHIR99021 metabolism has also been verified by western blot and immunocytochemistry confirming enhanced accumulation and subsequent translocation of B-catenin, a component of the canonical Wnt-pathway. Our results demonstrate that our Ru-based cages allow for temporal control over CHIR99021 bioactivity in cell culture with minimal toxicity, an important step towards scaled, automated, and reproducible stem cell differentiation for precision medicine and beyond.

Light-induced structural changes in B12-dependent photoreceptor CarH revealed by temperature-scan crystallography

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CarH is a B12-dependent photoreceptor that regulates carotenoid biosynthesis in bacteria as a light-responsive transcriptional repressor. Upon light exposure, photolysis of the adenosylcobalamin (AdoCbl) cofactor triggers protein conformational changes that directly alter the DNA binding properties of CarH. We apply temperature-scan cryo-crystallography to provoke and probe light-induced responses in photoactive CarH crystals. We have captured local structural changes associated with the initial bond-breaking event in the B12 cofactor, followed by global protein structural changes that alter interactions between subunits within the tetrameric assembly. Light-induced difference maps at various temperatures reveal a bifurcating pathway, suggesting alternative structural responses to light. These findings may provide mechanistic insights into how the B12-dependent photoreceptor regulates gene expression in response to light at the molecular level.

Assessing skin and eye safety for far-UVC disinfection: insights from the Blueprint for Far-UVC

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Protection from infectious aerosols is both a significant challenge and a remarkable opportunity for improving public health. Far-UVC (200–235 nm) is a candidate for airborne disinfection in occupied spaces, making its photobiological safety for skin and eyes a central question. The Blueprint for Far-UVC synthesizes experimental, modeling, and field data under current ICNIRP and ACGIH exposure limits. Protein absorption in the outer epidermis and anterior eye structures limits penetration relative to longer wavelengths. Across 3D skin models, ex vivo skin, and animal studies, filtered krypton chloride and 233 nm LED sources produce little or no DNA damage in basal cells at microbicidal doses, do not induce erythema in volunteers at exposures many times higher than present limits, and have not produced skin cancer in long-term mouse studies. For the eye, rodent experiments show damage largely confined to the most superficial corneal epithelial layers, and early human data from ceiling installations have not detected clinically significant changes in visual function or ocular surface health at realistic doses, although transient discomfort at higher single exposures suggests additional mechanisms.

Our conclusions are drawn from in-depth analyses of technical domains, parametric models developed to contextualize far-UVC's potential against existing interventions, and over 100 interviews with experts in the field. These efforts have enabled us to identify the research needs and practical considerations for deploying far-UVC in real-world settings, ensuring that its potential is maximized to reduce airborne transmission while appropriately addressing safety.

Patterns in Polyphylla: shifts in coloration and pattern in response to climate change.

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Climate change is causing shifts towards hotter, more arid environments, generating intense selective forces on thermoregulation and water balance across taxa. In insects, many aspects of color and pattern impact thermal biology and hydroregulation. For example, melanin – a dark, hydrophobic pigment– increases heat gain and reduces water loss when deposited in the cuticle. Whereas, white structural coloration can reduce heat gain by reflecting near-infrared (NIR) radiation. We wanted to know if these aspects of color are shifting with climate change in Polyphylla rugosipennis. P. rugosipennis is a black, nocturnal beetle with white stripes composed of individual whitescales. We analyzed the proportion of white versus black coloration in 290 museum specimens of P. rugosipennis collected in northern Arizona between 1944-2024. Specifically, we measured scale area, density, and stripe area. Preliminary results suggest that stripe area is increasing, while individual scale area and density remain the same. We hypothesize that these changes increase reflected NIR, subsequently reducing heat gain during inactive periods, while maintaining the water retention benefits of melanin. We plan to assess the relationship between stripe area and NIR reflectance by altering stripe size and measuring heat gain via thermal imaging. Our results suggest that insects may be able to respond to climate change via shifts in pigmentation and patterning, which may help buffer them from a warming world.

Photosynthetic bacteria for light-driven energy production and environmental bioremediation

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Photosynthetic bacteria are emerging as versatile platforms for sustainable energy production and environmental bioremediation. These microorganisms are able to harvest solar energy and convert it into chemical energy through anoxygenic photosynthesis, operating eLiciently under low light and oxygen-limited conditions. Their remarkable metabolic flexibility enables the direct production of energy carriers such as hydrogen, reduced organic compounds, and bioelectricity, making them attractive candidates for next-generation bio-based energy technologies. In biohybrid and bioelectrochemical systems, photosynthetic bacteria can drive extracellular electron transfer processes using light as the primary energy input, oLering a renewable route to electricity generation and solar-to-chemical energy conversion.

In parallel, photosynthetic bacteria play a significant role in bioremediation due to their capacity to tolerate, transform, and immobilize a wide range of pollutants. Many species can thrive in contaminated environments and actively remove heavy metals from soil and water In plant-associated systems, these bacteria can stimulate plant growth by improving nutrient availability, reducing metal toxicity, and enhancing stress tolerance, thereby supporting phytoremediation strategies. Their ability to function in complex and polluted matrices makes them particularly suitable for real-world environmental applications.

The coupling of light-driven metabolism with pollutant removal oLers unique advantages, including reduced operational costs, minimal external energy requirements, and the possibility of simultaneous energy recovery and environmental cleanup. Overall, the integration of photosynthetic bacteria into energy and environmental technologies represents a promising strategy to address global challenges related to clean energy generation, pollution mitigation, and ecosystem restoration within a sustainable and circular framework globally.

Photosensitized Formation of Singlet Oxygen Photoreceptor Outer Segments (POS) Discs after Photobleaching of Rhodopsin

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Exposure of the retina to visible light leads to the visual perception which is initiated by photoisomerization of the visual pigment chromophore, 11-cis-retinylidene SchiA base linking it to a specific lysine residue on the protein, opsin. This is followed by the hydrolysis of all-trans-retinal (AtRal). AtRal is a reactive aldehyde and a potent photosensitiser which upon absorption of light in the presence of oxygen photosensitizes generation of singlet oxygen. Therefore, the exposure of the dark-adapted retina to light causing rapid bleaching of rhodopsin and photoexcitation of AtRal can induce retinal damage. The aim of this study was to determine the yields of singlet oxygen generation by POS discs isolated from dark-adapted bovine retinas as a function of time after photobleaching and compare the kinetics with the kinetics of AtRal hydrolysis and enzymatic reduction. The hydrolysis of ATR after photobleaching of rhodopsin was monitored using intrinsic tryptophan fluorescence. The reduction of AtRal was monitored in the presence of NADPH/ATP by retinol fluorescence. Phosphorescence of singlet oxygen at 1270 nm was monitored after a 5 ns 422 nm laser pulse excitation. The yield of singlet oxygen sharply increased immediately after 1-minute photobleaching which was followed by a slower increase matching the kinetics of AtRal hydrolysis. The reduction of ATR to retinol led to a partial decrease of singlet oxygen yields. In conclusion, photobleaching of POS discs results in a rapid increase in the yield of singlet oxygen that occurs on a faster timescale than hydrolysis of AtRal.

Novel heteroleptic iridium(III) complexes containing COUBPY ligands for effective photoinduction of ferroptosis for cancer therapy

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Cancer remains a major public health challenge, largely due to tumors that resist conventional treatments such as chemotherapy, radiotherapy, and immunotherapy. Photodynamic therapy (PDT) has emerged as a powerful alternative, leveraging light-activated photosensitizers to generate reactive oxygen species (ROS) that selectively eradicate tumor cells. Transition metal complexes (TMCs), especially cyclometalated iridium(III) complexes of the type $[Ir(C^N)_2(N^N)]^+$ (where C^N denotes a cyclometalated ligand and N^N a diimine ligand), stand out for their unique photophysical and photochemical properties, and have been widely explored as luminescent and photosensitizing agents. However, conventional Ir(III)-based photosensitizers suffer from low absorption at long wavelengths, limiting their efficacy against large, hypoxic tumors. This study reports the development of heteroleptic Ir(III) complexes activated within the phototherapeutic window, rationally tuned for lipophilicity, cytotoxicity, and multifunctionality through incorporation of coumarin-based COUBPY ligands. These complexes preferentially accumulate in the mitochondria of cancer cells, where light activation induces the photogeneration of a series of Type I ROS, including superoxide, hydroxyl radicals and hydrogen peroxide. Encapsulation in polymeric nanocarriers further improves delivery and therapeutic efficacy. Strikingly, these Ir(III)-COUBPY systems induce non-canonical cell death pathways, notably ferroptosis, as demonstrated by light-driven lipid peroxidation, glutathione oxidation and depletion, intracellular ATP photodepletion, and rescue by ferrostatin-1 (Fer-1). Photobiological studies in 3D tumor spheroids confirmed superior cellular uptake of the Ir nanoformulations, contributing to the overall improved phototoxic efficiency. This work establishes Ir(III)-COUBPY complexes as next-generation PDT agents capable of overcoming key limitations of current therapies.

From Photons to Biology: Mechanistic Insights into Visible Light–Induced Skin Damage and Photoprotection Strategies

Solar radiation–induced skin damage has historically been framed through the lens of ultraviolet (UV) exposure; however, emerging evidence demonstrates that visible light (VL, 400–700 nm) and long-wavelength UVA1 (370–400 nm) account for the majority of daily solar energy reaching the skin and play a critical role in cutaneous biology. This session will bring together leading experts in photobiology, dermatology, and translational science to examine how long-wavelength light drives oxidative stress, pigmentation, inflammation, photoaging, and potentially photocarcinogenesis across diverse skin phototypes.

Presentations will address mechanistic pathways linking VL and UVA1 to reactive oxygen species generation, melanogenesis, matrix remodeling, and cellular stress signaling; clinical responses, including erythema, persistent pigmentation, and photoadaptive conditioning; and the limitations of current photoprotection paradigms that remain largely UV-centric. Special emphasis will be placed on emerging photoprotection strategies beyond spectral filtering, including the role of topical antioxidants, free-radical quenchers, and multimodal protection concepts designed to mitigate biologic damage rather than simply attenuate incident photons.

The session will also explore implications for skin aging, pigmentary disorders, and long-term photocarcinogenic risk, highlighting the need for updated frameworks that better reflect real-world solar exposure. Collectively, these talks aim to redefine photoprotection and skin health across the visible spectrum, bridging fundamental photobiology with clinical relevance, future regulatory, fundamental studies and therapeutic considerations for the field.

Combined Photodynamic Therapy and Laser Treatment for Capillary Malformations: A Prospective Clinical Study

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Background: Capillary malformations (CMs), commonly known as port-wine stains, often respond incompletely to laser monotherapy, especially in thickened or treatment-resistant lesions. Photodynamic therapy (PDT) has emerged as a promising adjunct modality due to its unique vascular-targeting mechanism. This study evaluates the clinical outcomes of combining PDT with selective laser therapy for improved efficacy in CM management.

Methods: A prospective study was conducted involving 74 patients with facial and cervicofacial capillary malformations treated from 2022–2025. All patients received PDT using topical photosensitizer ALA/porphyrin precursor, followed by sequential laser irradiation (585 nm PDL for superficial vessels and 1064 nm Nd:YAG for deeper components). All patients was observed for several tests - reduction in erythema intensity (colorimetry), vessel density (Doppler/ultrasound), physician global assessment (PGA), patient satisfaction. Follow-up check was performed at 1, 3, and 6

months. Statistical analysis used paired t-tests and multivariate regression.

Results: Combination PDT + laser therapy resulted in significantly higher improvement compared with laser-only outcomes. Mean erythema reduction was 78% at 3 months and 86% at 6 months ($p < 0.001$). Ultrasound demonstrated a 52% decrease in vessel density after combined treatment. Patients with hypertrophic or previously resistant CMs showed notably enhanced responses ($p = 0.003$). Adverse effects were mild: transient edema, crusting, and photosensitivity; no scarring or pigment loss reported. Overall patients satisfaction rate were 92%.

Conclusion: The combined PDT + laser protocol offers superior clearance of capillary malformations compared with laser monotherapy alone. Sequential activation of the photosensitizer followed by targeted vascular photocoagulation enhances depth penetration and long-term outcomes, particularly in resistant or nodular lesions.

Engineering Titanium Dioxide Nanoparticles for Enhanced Antimicrobial Photodynamic Therapy of Biofilm-Associated Infections

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Antimicrobial photodynamic therapy (aPDT) is a promising strategy for treating biofilm-associated infections by generating reactive oxygen species (ROS under light activation, bypassing conventional antibiotic resistance mechanisms. Titanium dioxide nanoparticles (TiO_2 NPs) are attractive inorganic photosensitizers due to their chemical stability and strong oxidative potential; however, their effectiveness in aPDT is limited by poor visible-light absorption and instability of photoinduced defect states.

Here, we present a materials engineering strategy to enhance the photobiological performance of TiO_2 NPs for antimicrobial PDT through controlled doping, defect stabilization, and scalable synthesis. Nitrogen-doped TiO_2 nanoparticles were further modified via hydrogen-assisted magnesiothermic reduction to produce reduced nitrogen-doped TiO (H:Mg–N–TiO_2) with stabilized oxygen vacancies and persistent Ti^{3+} species. X-ray photoelectron spectroscopy confirms the formation of substitutional Ti–N bonds that suppress defect reoxidation, enabling sustained ROS generation under visible-light irradiation. These engineered nanoparticles exhibit significantly enhanced photodynamic activity, resulting in a threefold increase in antibiofilm efficacy compared to undoped or commercially available TiO_2. Potent antimicrobial effects were demonstrated against clinically relevant Gram-positive and Gram-negative biofilm-forming pathogens, including Streptococcus mutans, Porphyromonas gingivalis, and Fusobacterium nucleatum.

To extend translational relevance, we further developed a scalable mechanochemical synthesis approach using ball milling to produce nitrogen- and carbon-co-doped TiO_2 NPs. This method yields a unique multiphase architecture (anatase–rutile–TiO_2-II) with enhanced visible-light absorption and ROS production, while offering a cost-effective pathway for large-scale manufacturing.

Together, these results establish defect-engineered TiO_2 nanoparticles as highly effective inorganic photosensitizers for antimicrobial PDT, providing a versatile platform for combating biofilm-associated infectious diseases.

Monitoring the triplet excited states of synthetic and natural melanins by application of diene probes with di8erent electric charge

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Aerobic photoreactivity of melanin, responsible for generation of reactive oxygen species, could contribute to melanomagenesis and certain other pathologies. Importantly, the participation of an excited triplet precursor in photogeneration of a delayed emissive signal of melanin was shown by direct time resolved EPR study, and the involvement of melanin triplet excited states in carcinogenesis due to chemically generated excited electronic states has been implicated. In the present study, to characterize reactivity of triplet excited states of melanin an indirect approach was used by employing selected triplet state quenchers – sorbic acid (SAC), sorbic alcohol (SAL) and sorbic amine (SAM). The eQect of these quenchers on photogeneration of singlet oxygen by synthetic dopa-melanin, 5-S-cysteinyldopa melanin and nanoaggregates from melanosomes of diQerent human hair, was compared. The data revealed that SAM inhibited most eQiciently the photogeneration of singlet oxygen by melanins with SAC being relatively less eQicient. This could be explained by diQerent binding interaction of positively charged SAM versus negatively charged SAC with negatively charged melanin monomers. The strongest quenching eQect of the diene probes was detected for the synthetic eumelanin, particularly when melanin was excited by short wavelength UVA radiation. The results suggest that photogeneration of singlet oxygen by melanin occurs via energy transfer from diQerent pools of melanin triplet excited states exhibiting diQerent energies.

Computational studies of potassium-selective channelrhodopsin

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We studied the potassium channel rhodopsin 1 (HcKCR1) from Hyphochytrium catenoides using multiscale computer simulations. We started with nonadiabatic molecular dynamics simulations to probe the photoisomerization of the retinal chromophore and understand how it triggers a series of side-chain reorientations. We compared the results to those of recent structural studies by Ernst and coworkers, in which two structures were solved, in the absence and presence of light. Additionally, we probed the formation of the transmembrane K^+ conduction pathway using computational electrophysiology. Our molecular dynamics simulations revealed a K^+ flux through an experimentally determined structure under illumination. We resolved the mechanism of K^+ ion conduction and the critical role of water.

Light-activatable ethyl cellulose ethanol ablation for treatment of tumors and promotion of anti-tumor immune effects

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Surgical excision is the gold standard for localized cancer treatment; however, many tumors are unresectable due to size, extent, comorbidities, or location. At diagnosis, up to 70% of hepatocellular carcinomas1, 75% of colorectal metastases in the liver2,3, and 68% of pancreatic tumors4 are unresectable. Thus, there is a critical need to develop minimally invasive techniques targeting these intractable tumors. To address this challenge, we developed a light-activatable sustained-exposure ethanol injection technology (LASEIT), incorporating benzoporphyrin derivative (BPD), ethanol, and ethyl cellulose, a biocompatible polymer, for the treatment of localized tumors using a combination of photodynamic therapy (PDT) and ethanol

ablation. This LASEIT formulation can be injected intratumorally where the ethyl cellulose forms a gel, trapping BPD and ethanol in the targeted tumor. This technology prevents the leakage of ethanol into the surrounding tissue, preventing harmful side effects while ensuring BPD remains concentrated in the tumor. Moreover, this colocalization of BPD with the gel enables fluorescent monitoring of the ethanol distribution and ablation coverage in the tumor.

When light activated, this approach leverages the cytotoxic effects of PDT through the production of reactive oxygen species in combination with the necrotic effect of ethanol ablation via cytoplasmic dehydration, providing a dual therapeutic effect. This combination treatment also promotes an anti-cancer immune effect in distant tumors through significant immune cell exposure to damage-associated molecular patterns (DAMPs). Through these synergistic effects, LASEIT can effectively treat unresectable tumors through a minimally invasive approach while simultaneously inducing an immune response capable of reducing secondary tumor growth.

Photochemical approaches for strengthening cancer immunotherapy

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Photodynamic therapy (PDT) combines photosensitizers with light activation to generate reactive oxygen species (ROS), producing targeted cytotoxicity. Beyond direct tumour destruction and vascular shutdown, PDT enhances cancer immunotherapy by inducing immunogenic cell death, local inflammation, and immune cell recruitment into light-exposed tumour tissue. I will demonstrate how PDT significantly improves Bacille Calmette-Guérin (BCG) efficacy in bladder cancer treatment. In a preclinical bladder cancer model, combining BCG with PDT markedly increased antitumour activity. In vitro and in vivo studies using MB49 carcinoma cells and immunocompetent mice show that BCG–photosensitizer complexes elicit dose-dependent cytotoxicity, drive transcriptomic reprogramming, and achieve durable tumour remission in some animals. Photochemical internalisation (PCI), an advanced endosomal escape technology derived from PDT, further expands therapeutic potential. PCI uses photosensitisers that accumulate in endolysosomal membranes and, upon light activation, generate ROS that rupture these compartments, releasing entrapped agents into the cytosol. This enables efficient endosomal escape of peptide antigens, driving robust activation of antigen-specific CD8+ T cells and supporting effective anti-cancer vaccine strategies. In preclinical models, fimaporfin-based PCI combined with tumour-specific peptides and adjuvants induces strong, durable anti-tumour immune responses. I will also highlight proof-of-concept work on PCI-mediated, light-controlled elimination of PD-L1-expressing suppressor cells, offering a selective strategy to improve specificity and overcome resistance in PD-L1-positive cancers. Together, PDT and PCI underscore the versatility and translational promise of photochemical strategies. Integrating light-based modalities with immunotherapy opens new opportunities to enhance tumour-specific immune responses and achieve improved clinical outcomes across diverse cancer types.

An overview and a New Perspective on Light Dosimetry in Photodynamic Therapy

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Light dosimetry includes light dose that is total number of photons per unit area and dose rate that is the total number of photons per unit area per second. Early studies suggest that the response to photodynamic therapy (PDT) is directly proportional to the light dose and photosensitizer concentration. Later it was shown that the light dose rate affects the PDT efficacy as too high of a dose rate will result in high rate of oxygen consumption in comparison to oxygen supply, which will result in an ineffective PDT. Furthermore, the dose and dose rate have been shown to impact immune response to PDT, as too high of both variables will result in rapid vascular shutdown and poor anti-tumor immunity. The above is true for external beam PDT (EB-PDT) where the light is administered by illuminating the surface of malignant tumors. These relationships do not hold when using EB-PDT to treat bacteria, where oxygen supply is in abundance. The above-mentioned light dosimetry criteria are also not accurate in the case of interstitial PDT (I-PDT) where the laser light is administered via optical fibers inserted into large (≥ 10 mm) solid malignancies. In I-PDT, both the light dose and dose rate need to exceed a threshold for effective therapy, and oxygen consumption is not directly affected by the dose rate. In this talk, we will discuss how to compute and accurately define light dose and dose rate and plan light dosimetry for effective EB-PDT and I-PDT in preclinical and clinical settings.

Comparative Evaluation of Perfluorocarbon Core Dependent Nanodroplets for Enhanced Photodynamic Therapy in 3D Head and Neck Cancer Spheroids

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Tumor hypoxia in solid cancers, such as head and neck carcinoma (HNC), leads to aggressive cancer phenotypes, poor clinical outcomes and severely limits the efficacy of oxygen-based therapies such as photodynamic therapy. Literature has shown that perfluorocarbon nanodroplets (PFC-NDs) have excellent oxygen carrying capability and can alleviate tumor hypoxia. These versatile nanocarriers can also encapsulate drugs and chemotherapeutic agents, thus providing a multifaceted approach to treat cancer. Perfluoropentane nanodroplets (PFP-NDs) loaded with photoactivable benzoporphyrin derivative (BPD) have been characterized before and shown to reduce tumor hypoxia and improve PDT efficacy. However, a comparison of different types of perfluorocarbons as nanocarriers and their efficacy towards treatment has not been thoroughly investigated. In this study, we developed and compared BPD loaded perfluorohexane NDs (PFH-NDs) with BPD loaded PFP NDs. Differences in vapor pressure and oxygen solubility lead to changes in ease of synthesis and therapeutic outcomes. Loading efficiency of PFCs in PFP-NDs and PFH-NDs was compared using fluorine nuclear magnetic resonance. Functional characterization of NDs was assessed by comparing stability, oxygen carrying capability and singlet oxygen generating capability following BPD activation. Three-dimensional tumor spheroids derived from FaDu and Cal27 were used to evaluate ND mediated hypoxia alleviation and PDT efficacy. It was observed that these NDs are able to outperform free BPD in terms of PDT efficacy, thus highlighting the importance of selecting perfluorocarbon core in engineering nanotherapeutics. This study establishes a comparative framework for optimization of PFC-NDs and supports their potential in overcoming tumor hypoxia in complex in vivo models.

Optimizing the phototherapy effects of metallodrug photosensitizers for cancer treatment

Ge Shi, Alisher Talgatov, Dalton Lucas, Broderick Nelson, Abbas Vali, Gurleen Kaur, Brayden Stackhouse, Kim Luu, Colin G. Cameron, Sherri A. McFarland

The University of Texas at Arlington

Cancer remains a global health challenge, and tumor hypoxia could hinder effective treatment. Low oxygen levels disrupt drug uptake

and function while driving adaptive cellular responses that promote therapeutic resistance. In photodynamic therapy (PDT), light activation of photosensitizers (PSs) in the presence of oxygen generates singlet oxygen and other reactive oxygen species (ROS) that selectively damage tumor cells with minimal dark toxicity. PDT has emerged as a promising treatment modality, supported by an increasing number of successful clinical trials. However, its reliance on molecular oxygen renders PDT particularly vulnerable to hypoxic tumor microenvironments. Building on our development of transition metal complexes as next-generation PSs with alternate mechanisms of action, we will present proof-of-concept strategies for achieving light-induced cytotoxicity under both normoxic and hypoxic conditions. One of our lead compounds, TLD1433, is currently in Phase 2 clinical trials (NCT03945162) for the PDT treatment of bladder cancer. We further explore optimization of PDT efficacy by modulating key light parameters and evaluating potential induction of anti-tumor immune responses. While hypoxia-tolerant photocytotoxicity remains relatively uncommon, uncovering such activity provides valuable insight into alternative photochemical pathways and may inform the design of new light-responsive therapeutics with broader biomedical applications. Even if hypoxia is not clinically limiting, elucidating oxygen-independent photoreactivity provides mechanistic insights that extend to photocatalysis, photoredox chemistry, and energy-conversion systems.

Dermal application of perfluorooctanoic acid (PFOA) in SKH-1 hairless mice heightens UVB-induced DNA damage and hepatotoxicity

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Abstract: Perfluorooctanoic acid (PFOA) is a well-known carcinogen and immune disruptor frequently used for consumer and industrial applications. PFOA is highly resistant to environmental degradation, and its presence in water sources used for drinking and bathing has caused growing concern. Dermal penetration of PFOA has been demonstrated as a significant route of exposure. Additionally, solar ultraviolet B radiation (UVB) is known to cause DNA damage forming bulky DNA adducts, often resulting in UV-signature mutations that cause photocarcinogenesis. With this work, we sought to determine whether an acute PFOA exposure exacerbates the effects of UVB exposure. We hypothesize that exposure to PFOA will sensitize mice to UVB-induced DNA damage, hepatotoxicity, and immunotoxicity. SKH-1 hairless outbred mice were exposed to PFOA or vehicle control for four consecutive days. On day four, half the mice from each treatment group were exposed to UVB radiation. Mice were necropsied 24 hours after UVB exposure. The combination of PFOA and UVB treatment resulted in a significant increase in relative liver weight and several DNA damage markers in the skin and liver of mice. These results indicate that dermal PFOA exposure may have a modifying effect on UVB-induced DNA damage and systemic toxicity, providing insight into mechanisms by which environmental toxicants can aggravate photocarcinogenesis.

The CIE Spectral Luminous Efficiency Function V(λ) Is Not a Photobiological Action Spectrum

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US Army Public Health (retired)

There have been recent suggestions for small changes in the century-old spectral luminous efficiency function, V(λ), the basis of photometry. This was based on the apparent under-weighting of retinal sensitivity in the short-wave cone (SWC) in the violet end of the spectrum. The International Commission on Illumination (the CIE) established the V(λ) function in 1924. However, V(λ) is not a single action spectrum but an envelope spectral response function to cover the three action spectra for the three individual cone (color) photoreceptors (short-wave, medium-wave and long-wave) cones). The framers of the original V(λ) function intended this to emphasize the importance of the dominance of medium- and long-wave cones in the 2° fovea centralis where visual acuity is greatest. Green and red wavelengths are sharply focused on the retina, but because of greater chromatic aberrations, indigo and violet wavelengths are focused in front of the retina and contribute little to fine visual acuity. Furthermore, lenticular fluorescence of short visible wavelengths further reduces fine visual acuity. Rifle marksmanship competitors wear yellow (violet blocking) glasses to enhance visual acuity. The originators of the V(λ) function obviously weighted visual acuity higher than color perception. This is not unreasonable in an era of incandescent lamps and black-and-white print with little color in printing. Would it be better to have multiple spectral functions as we already have (e.g., V′(λ) rod function, rather than adjusting the traditional CIE V(λ) function? One useful outcome of this proposal was the development of CIE cone fundamentals for color vision reseach.

Consequences of exposure to far-UVC radiation on the eye's tear film

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The use of far-UVC (222 nm) is being considered as a prevention strategy for airborne infections in public spaces. However, before implementing far-UVC, it is crucial to demonstrate its safety. Exposure to far-UVC has been documented to cause ocular irritation similar to the sensation of a foreign body in the eye. This ocular irritation can take several hours to resolve, and it is unknown whether chronic exposure to this light could lead to long-term ocular consequences. The tear film represents the eye's first line of defense against environmental aggressions. It is composed of three layers (tear film lipid layer (TFLL), aqueous layer and mucoid layer), which can all be affected by far-UVC and explain this discomfort. We aimed to determine the consequences of far-UVC exposure on the tear film, mainly focussing on the lipid and aqueous layer. A filtered KrCl lamp (Care 222 from Ushio-America) has been used to perform our tests. To mimic the TFLL we used a model consisting of a lipid film containing a mixture of polar (POPC) and nonpolar lipids (behenyl oleate and cholesteryl erucate) that we applied on an aqueous layer. This model of tear film has been exposed to far-UVC. We have measured the pH changes and oxidation status in the aqueous layer. Lipid degradation and oxidation by-products have been measured. Taken together, this project sheds some light on the safety of far-UVC exposure on ocular surface and whether photochemical by-products could produce adverse effects.

Translating targeted photodynamic platforms for immune-dermatology and precision photomedicine

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Photodynamic therapy (PDT) is undergoing a renaissance driven by advances in molecular

targeting, photosensitizer chemistry, and delivery platforms that enable precise, spatially confined immune modulation rather than nonspecific cytotoxicity. In this talk, I will describe the translational development of targeted photodynamic and photoimmunotherapy platforms building on prior innovations in the field and advanced through Nira Biosciences, with a focus on immune-dermatology applications.

Our work centers on a new class of antibody–photosensitizer conjugates based on a verteporfin-derived benzoporphyrin platform ("vertamax") engineered for controlled activation, improved photophysical performance, and tunable immune effects. By incorporating site-selective linker chemistry and intracellular activation mechanisms, vertamax conjugates remain functionally quenched until processed within target cells, reducing unintended phototoxicity in

illuminated tissues. When paired with antibodies targeting immune or epithelial surface markers, this approach enables localized photodynamic activation at moderate light doses while preserving surrounding tissue architecture.

Across preclinical dermatologic and oncologic models, vertamax-based photoimmunotherapy supports both effective lesion control and photodynamic priming of local immune responses. In ex vivo human skin and disease-relevant models, immune-targeted constructs enable selective depletion of pathogenic T cell populations, including tissue-resident subsets, while minimizing collateral damage. Tumor-directed constructs similarly demonstrate potent activity with favorable safety profiles in vivo.

I will highlight key technological innovations underlying this platform, including photosensitizer and linker design, conjugation strategies that improve reproducibility and pharmacokinetics.

Together, these advances illustrate how re-engineering PDT at the molecular and technological levels can expand its therapeutic scope toward precision immune modulation and enable new translational opportunities in immune-dermatology and oncology.

Image-guided photoimmunotherapy reveals immune priming and tumor–immune dynamics in preclinical models

Bryan Q. Spring

Translational Biophotonics Cluster, Northeastern University, Boston

Photoimmunotherapy (PIT) enables spatially precise tumor targeting while offering unique opportunities to modulate antitumor immunity. Realizing its full translational potential requires tools that can both elicit and directly observe immune responses within complex tumor microenvironments. In this talk, I will present recent advances combining immune-priming PIT strategies with technology development in multiplexed optical imaging.

Using a 3D allogeneic tumor–immune model, we evaluate EGFR-targeted photonano-immunoconjugates (PINCs), consisting of nanoliposomes bearing verteporfin–lipid conjugates and surface-conjugated antibodies. At sub-ablative light doses, PIT induces tumor cell stress and death while sparing immune cells, resulting in measurable immune priming, including enhanced immune cell infiltration. These findings support PIT as a controllable immunomodulatory intervention rather than a purely cytotoxic therapy and are complemented by emerging in vivo data in mouse tumor models.

To enable direct visualization of these processes, I will also highlight the development of a hyperspectral multiplexed multiphoton microendoscope designed for real-time imaging of tumor–immune cell interactions in confined tumor sites. This instrument integrates broadband femtosecond pulse excitation, high-dimensional spectral detection, and computational unmixing to simultaneously track multiple immune and tumor cell populations at cellular resolution.

Together, these advances illustrate how co-development of phototherapeutic agents and imaging technologies can accelerate translation, reveal mechanisms of immune priming, and guide synergistic photodynamic–immunotherapy strategies.

Light-Activated Natural Products as Deployable Antimicrobials

Brayden Stackhouse, Alisher Talgatov, Gurleen Kaur, Dalton Lucas, Broderick Nelson, Ge Shi, and Sherri A. McFarland*

The University of Texas at Arlington

Antibiotic resistance poses a major global health and agricultural challenge, threatening both human and animal health. We propose that light-activated natural product extracts derived from widely cultivable plants could serve as inexpensive, deployable anti-infective agents for use in resource-limited settings, including field applications and veterinary medicine. Light-triggered natural products can be highly potent and are particularly suited for topical or surface treatments where illumination is feasible, reducing the need for systemic antibiotics. We hypothesize that these extracts act through the light-induced production of reactive molecular species (RMS), leading to broad oxidative damage that may be less prone to conventional resistance mechanisms. Our preliminary results show that plant extracts containing light-responsive secondary metabolites display strong light-dependent antimicrobial activity. Ongoing studies aim to quantify activity and evaluate formulation strategies suitable for portable, phototherapeutic anti-infectives to prevent or control infection in field and veterinary environments.

Leveraging UV damage fingerprints to discover transcription factor binding sites

Scott Stevison, Hannah E Wilson, Levi Lamprey, John J Wyrick

Accurate mapping and subsequent discovery of transcription factor binding sites (TFBS) across the genome requires the development of innovative approaches. Here, we show that binding events induce distinct patterns of UV-induced cyclobutane pyrimidine dimers (CPDs), termed UV 'fingerprints', which can be exploited by machine learning methods to identify TFBS. As a proof of principle, we analyzed CPD-seq data from yeast cells using the Random Forest algorithm to identify 75 TFBS bound by the Hap2/Hap3/Hap5 ssTF complex, including ~25 new sites missed by previous chromatin immunoprecipitation (ChIP)-based experiments. Parallel analysis of additional transcription factors, including Gcr1, Mcm1, Reb1, and Nrg1/2, demonstrates how other machine learning models, including neural networks, may also be used to discover new binding sites. Our analysis indicates that the newly identified TFBS are associated with many genes that align with expected functional categories, and whose mRNA levels and associated damage patterns are downregulated in selected mutants. These findings indicate that unique UV damage patterns occurring at a wide variety of TFBS can be recognized by machine learning methods to map regulatory elements at single-nucleotide resolution.

Title: Blue light aminolevulinic acid photodynamic therapy does not induce DNA damage in human dermal fibroblasts

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Photodynamic therapy (PDT) is an established noninvasive therapeutic modality used to induce controlled apoptotic cellular death within targeted tissue and has shown great efficacy for a variety of dermatologic conditions. Despite the increasing clinical use of blue light (BL, 400-500 nm) PDT, the genotoxic safety has

not yet been established. This study is clinically relevant because non-targeted skin is also exposed during treatment, raising the question of whether the residual skin cells sustain DNA damage. We examined whether combination BL (417 ± 5 nm) and 5-aminolevulinic acid (5-ALA) PDT induces DNA damage in human dermal fibroblasts.

CRL-2617 and AG13145 fibroblasts were treated with 0, 0.5, or 1 mM 5-ALA and then irradiated with BL at 10, 30, or 45 J/cm². DNA damage in the form of cyclobutane pyrimidine dimers and 6-4 photoproducts was assessed at 3 and 24 hours after irradiation using ELISA and immunoblot assays, each experiment performed in duplicate. We did not detect formation of these photolesions under any treatment condition, as compared with significant DNA damage in the UVB-irradiated positive control. These findings support the conclusion that BL PDT is a DNA safe therapeutic modality when using a clinically relevant PDT light source and photosensitizer.

BODIPY dyes as photosensi3zers for photodynamic therapy

Shawn Swavey

University of Dayton

Photodynamic therapy is a more targeted treatment modality; utilizing light, oxygen, and a photosensitizer (prodrug) to induce cell damage and ultimately cell death. Current photosensitizers have many limitations leading to extensive studies over the past decade to develop the next generation of this prodrug. Boron dipyrromethene (BODIPY) dyes offer synthetic versatility along with many of the photophysical properties required by PDT. A major drawback of these small fluorescent dyes (SMFs) is their inability to populate the excited triplet state preventing photoreactions. Addition of heavy atoms to the core of these dyes enhances their spin-orbit coupling leading to high triplet state quantum yields. This presentation will describe recent advances made in the Swavey laboratory to generate unique BODIPY dyes with photosensitizer properties.

Photobiological Applications of Light-Activated Metallodrugs

Alisher Talgatov, Dalton Lucas, Broderick Nelson, Ge Shi, Gurleen Kaur, Brayden Stackhouse, Kim Luu, Abbas Vali, Colin G. Cameron, Sherri A. McFarland*

The University of Texas at Arlington

Photodynamic therapy (PDT) is a selective cancer treatment strategy that combines a nontoxic prodrug -known as a photosensitizer (PS)- with light and molecular oxygen to generate reactive molecular species (RMS) that induce localized cell death. Clinically approved PSs are typically organic tetrapyrroles (e.g.: Photofrin, the only FDA-approved PS for cancer therapy), which mediate their effects primarily through singlet oxygen (1O2) and other reactive oxygen species (ROS). Our research focuses on developing next-generation metallodrug PSs that leverage unique excited-state configurations and alternate modes of action for photocytotoxicity. One such compound, TLD1433 (Ruvidar™), a Ru(II) oligothienyl polypyridyl complex designed and synthesized in our laboratory, is currently in Phase 2 clinical trials (ClinicalTrials.gov identifier: NCT03945162) for photodynamic treatment of non-muscle invasive bladder cancer (NMIBC). In this work, we present a new class of Ru-based PSs structurally related to TLD1433 and demonstrate their potent light-driven cytotoxicity. These complexes expand the design space for metal-based PDT agents, offering tunable photophysical properties and potentially distinct modes of biological action. Beyond their therapeutic applications, these complexes provide a unique opportunity to probe fundamental photochemical and photobiological processes—offering insight into alternative modes of cellular damage and energy transfer that may be harnessed in other light-driven biomedical or materials applications.

Enzyme-coupled Isotope Dilu4on and Mobility Shi: Mass Spectrometry Assays for Non-adjacent DNA Photoproducts

Savannah S. Scruggs, Belle Endom, Hsin-Chieh Yang, Menqi Chai, Michael L. Gross, John-Stephen Taylor

Washington University in St. Louis

Adjacent cyclobutane dimers (CPDs) are the major UV-induced photoproducts of B DNA and lead to mutations and skin cancer if left unrepaired. Non-adjacent CPDs are a largely unexplored class of photoproducts that result from photodimerization of non-adjacent pyrimidines. These photoproducts cannot form in B DNA and were originally found to form in bulged loop DNA and in ethanol-denatured and desiccated DNA, and more recently in a 14-mer at low pH and in human telomeric DNA and G-quadruplex forming sequences in promoters at neutral pH in vitro. The formation and biological effects of non-adjacent CPDs in vivo are unknown. To study these photoproducts methods for their identification and sequencing are needed. Non-adjacent cyclobutane pyrimidine dimers formed in vitro have been assayed by enzyme-coupled mass spectrometry, but more sensitive techniques will likely be required to detect these infrequent products in vivo. We have previously described the preparation of C13-labeled non-adjacent thymidine CPDs for the assay of non-adjacent thymidine CPDs by enzyme-coupled isotope dilution mass spectrometry but only observed four HPLC peaks for the six possible isomers, only one of which could be assigned to a specific isomer. We are now able to assign three of the four observed HPLC peaks to specific isomers, but not the fourth peak which is a mixture of three isomers. We show, however, that it is possible to separate all six isomers by ion mobility mass spectrometry suggesting that this method may be very useful for the analysis of other complex mixtures of isomers.

Solvent-Controlled Relaxation Pathways of 1-Cyclohexyluracil: Twisted Intermediates in Protic Media and $^1n\pi^*$ Pathways in Aprotic Solvents

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Case Western Reserve University, OH

In our recent publication, we demonstrated that UV excitation of nucleobases drives the excited-state population from the bright $^1\pi\pi^*$ state to a ground-state twisted intermediate on a sub-picosecond timescale. This intermediate, experimentally identified for the first time in the photochemical relaxation pathways of nucleobases, subsequently undergoes nucleophilic water addition to form a photohydrate. In the present work, we extend this mechanistic framework to 1-cyclohexyluracil (1-CHU) by combining steady-state spectroscopy, femtosecond broadband transient absorption spectroscopy, and quantum-chemical calculations to investigate how chemical substitution and solvent environment modulate this relaxation pathway in both protic and aprotic solvents. Similar to uracil, 1-CHU undergoes rapid vibrational cooling from the initially populated $^1\pi\pi^*$ state on a sub-picosecond timescale. However, the subsequent relaxation pathways depend strongly on the solvent environment. In protic solvents, we observe a long-lived intermediate whose lifetime increases systematically with decreasing polarity. We assign this species to a hydrogen-bond-stabilized twisted ground-state intermediate. In contrast, in aprotic solvents, the relaxation pathway does not proceed through the twisted intermediate but instead involves a stabilized $^1n\pi^*$ state, which enhances intersystem crossing efficiency to the triplet manifold. These results demonstrate that the solvent environment plays a crucial role in controlling the formation of the twisted intermediate state and the photochemical relaxation mechanism of pyrimidine derivatives, which has important implications for the photostability, therapeutic study and chemical evolution of nucleic acid components.

Buffered saline injection enhance quantum-engineered mid-infrared laser thermal therapy: ex vivo feasibility evaluation

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In this work we evaluate the feasibility of novel quantum-engineered, mid-infrared (MIR) lasers (emitting 3- to 5-µm wavelengths) for safe and effective laser interstitial thermal therapy (LITT) of small tumors (< 1 cm3) in sensitive anatomical structures. We utilized a 1.5-W power output with an emission wavelength of 4.65 µm and fresh chicken breast tissue for our ex vivo studies. The tissue was illuminated with either an external beam or interstitially with a coupled fluoride-fiber optic inserted into the tissue. The laser power output was between 0.25-1.5 W with duty cycle 10% to 50%), and exposure time of 1-10 minutes. Saline buffer solution was injected at varying rates (0.10, 0.12, 0.15, and 0.20 ml/min) to the treated region, during laser illumination, to increase the effective optical absorption and resulting ablation zone. Ablation diameter was measured via optical imaging immediately after laser exposure. Tissue temperature was measured using thermocouples inserted into the tissue at 3, 5, 7 and 9 mm from the laser spot (2 mm diameter). Tissue charring occurred with injection rate of 0.10 ml/min and 1.5 W. An ablation zone of 1.1 cm diameter with no charring was observed at 1.5 W with 0.15 ml/min saline injection for 10 mins. An injection rate of 0.20 ml/min resulted in reduction of the ablation zone. These results suggest interstitial buffered saline injection can improve LITT with MIR laser.

Development and study of new physiologically useful photoprecursors to hydropersulfides (RSSH)

John P. Toscano

Johns Hopkins University

Hydrogen sulfide (H2S) has emerged as a vital small molecule signaling agent and biological effector along with nitric oxide (NO) and carbon monoxide (CO). However, despite its importance, the physiological chemistry and mechanism(s) of H2S function remain to be fully elucidated. It has been proposed that at least a portion, if not the majority, of H2S-mediated effects are not due to H2S per se, but rather to H2S-derived and/or related reactive sulfur species. Of particular interest are RSSH, which are intimately linked biochemically to H2S. Emerging evidence has demonstrated that the pharmacological application of RSSH can effectively inhibit/prevent cellular damage resulting from oxidative and/or electrophilic stress. RSSH are inherently unstable and undergo rapid disproportionation/decomposition in aqueous solution producing polysulfides, H2S, and elemental sulfur. The unstable nature of RSSH makes it challenging to examine their biological roles. Over the past few years, a number of small-molecule donors that efficiently release RSSH in response to various stimuli have been developed. These RSSH donors have provided chemical tools to help uncover the potential function and role of RSSH as physiological signaling and protecting agents. This presentation will focus on the development of new, physiologically useful photochemical precursors to RSSH.

Repurposing Bacterial Photosynthesis.

Massimo Trotta

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Research over the past several decades has provided a comprehensive understanding of bacterial photosynthesis and the molecular mechanisms governing its solar light transduction. This established knowledge base signifies the field's maturity. Consequently, attention is now pivoting towards exploring and implementing applications that leverage bacterial photosynthetic components as functional soft materials for roles distinct from their biological function. These efforts are rapidly transitioning from conceptual exploration to tangible applications within material science. This contribution will present a selection of applications relevant to promising new technologies. By addressing both current potential and inherent limitations, this analysis aims to provide a balanced illustration of utilizing the bacterial photosynthetic apparatus and its components in emerging technological domains.

Project APACE - Towards a bio-mimetic sunlight pumped laser based on photosynthetic antenna complexes (Project n. 101161312) funded by Horizon-European Innovation Council is acknowledged.

Comparative Photophysical and Photodynamic Inactivation of Aspergillus niger Spores and Staphylococcus aureus by Rutin- and Quercetin-Loaded Nanoemulsions

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Natural flavonoids such as rutin and quercetin display promising photochemical and photodynamic properties; however, their application is often limited by poor aqueous solubility, aggregation, and inefficient excited-state processes. In this work, we present a comparative study of rutin- and quercetin-loaded orange-oil nanoemulsions, focusing on the relationship between photophysical behavior, reactive oxygen species (ROS) generation, and photoinactivation efficiency against microbial targets. Nanoemulsions were prepared by emulsification-based methods and compared to the corresponding free flavonoids in aqueous media. The photophysical properties of rutin were investigated using steady-state fluorescence spectroscopy, excitation–emission matrices, and quantum yield determination. Encapsulation led to enhanced fluorescence intensity and blue-shifted emission, indicating reduced aggregation and improved stabilization of the excited state. In contrast, the photodynamic activity of quercetin nanoemulsions was evaluated through singlet oxygen ($^1O_2$) generation using chemical probes under blue-light irradiation, revealing significantly higher ROS production compared to free quercetin. Photoinactivation assays were conducted against Aspergillus niger spores and Staphylococcus aureus under visible-light exposure. Both nanoemulsion systems exhibited enhanced antimicrobial activity relative to their free counterparts, with quercetin-loaded nanoemulsions showing superior photoinactivation efficiency, consistent with their higher $^1O_2$ generation capability. Rutin nanoemulsions demonstrated moderate but reproducible antimicrobial effects, associated with their improved photophysical stability.

Light-activated silver nanoparticles for inactivation of antibiotic-resistant bacteria and elimination of biofilms

Varsha Godakhindi, Adeola Sorinolu, Anjumana Jannati Nur, Bhoomika Karamchandani, Mariya Munir, Juan Luis Vivero-Escoto

Antibiotic-resistant bacteria (ARB) represent a growing global health challenge, as highlighted by the WHO Global Antimicrobial Surveillance System report (2017). Conventional strategies—such as antibiotic cocktails, engineered bacteriophages, and antimicrobial peptides—seek to disrupt multiple bacterial pathways, yet each faces limitations: cocktails accelerate resistance development, while bacteriophages and peptides are prone to proteolytic degradation.

Compounding this issue, microbial biofilms pose a major public health threat, accounting for more than 50% of hospital-acquired infections. Biofilms exhibit heightened tolerance and resistance to antibiotics and antiseptics, frequently resulting in treatment failure and chronic infection persistence.

Light-activable silver nanoparticles (AgNPs) have emerged as a promising alternative for overcoming these barriers. Upon illumination, AgNPs release silver ions (Ag^+) and generate reactive oxygen species (ROS), both of which synergistically inactivate bacteria.

Functionalization with photosensitizers further enhances their antibacterial potency, while controlled release kinetics of Ag^+ and ROS are critical for efficacy against resistant strains. Recent studies demonstrate that AgNPs can penetrate biofilms and, when activated by light, effectively inhibit biofilm growth. These findings underscore the potential of light-responsive AgNPs as a novel therapeutic platform to combat antibiotic resistance and biofilm-associated infections, offering a pathway toward more effective clinical interventions.

My Multi-Decade Entrepreneurial Journey in Playing with Light

Sean Wang

BWTEK Medical, Newark, Delaware

This talk reflects on a multi-decade journey as a serial entrepreneur working at the intersection of photonics, laser technologies, and medical devices. The path has been shaped far less by uninterrupted success than by constant experimentation, unexpected setbacks, and the occasional breakthrough that made the struggle worthwhile. Translating innovations from the lab bench to real-world clinical impact has required navigating scientific uncertainty, regulatory complexity, and the unpredictable dynamics of early-stage ventures.

Across numerous companies—few that flourished, many that did not—the most enduring lessons emerged from failure: the value of disciplined iteration, the importance of listening deeply to clinicians and patients, and the need to align elegant science with practical constraints. When success did arrive, it came from teams that embraced curiosity, resilience, and a willingness to challenge assumptions.

This presentation distills those experiences into practical guidance for researchers and innovators seeking to move academic discoveries toward technologies that meaningfully improve patient care. It is ultimately a joyful journey—one that aPirms how thoughtful science, paired with persistence and humility, can change lives.

Effects of chronic 222 nm or 254 nm radiation exposure on SKH-1 mice

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Germicidal ultraviolet radiation is a promising technology to help prevent the spread of disease. Most germicidal systems either utilize conventional 254 nm low-pressure mercury lamps, which are installed with the goal of only irradiating the upper portion of a room to limit the dose received by occupants, or far-UVC lamps, usually 222 nm emitting KrCl lamps, which expose the entire room volume including occupants. Previous studies on the impact of chronic ultraviolet exposure on mice were most interested in exposure from sunlight and therefore focused on the ultraviolet A and B wavelength ranges rather than the germicidal wavelengths examined here.

This presentation will report on the chronic exposure of SKH-1 mice, both male and female, from either 254 nm or 222 nm radiation over a 30-week period. Incidence of carcinogenesis was evaluated, as well as additional physiological and biophysical endpoints related to the skin. While the SKH-1 mouse model is not traditionally used for evaluation of eye health, these mice were also assessed for changes in visual acuity and eye health throughout the study. Together, this data is important for understanding the long-term safety considerations for germicidal ultraviolet radiation.

Ir(III) and Ru(II) photosensitizers for phototherapy and antimicrobial photodynamic therapy

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Transition-metal complexes with near-infrared (NIR) absorption and emission are desirable for a variety of applications, including telecommunication, phototherapy, bioimaging, and biosensing. Many Ir(III) and Ru(II) complexes have been reported as photosensitizers (PSs) for phototherapy or bioimaging reagents. However, most of them only absorb strongly in the blue or green spectral regions. Exploration of Ir(III) and Ru(II) PSs with NIR absorption and emission has been an area of interest for photodynamic therapy (PDT), photothermal therapy (PTT), and bioimaging. We have designed and synthesized several series of mononuclear and dinuclear Ir(III) and Ru(II) complexes that exhibit strong NIR absorption and emission in the regions of 730-920 nm for PDT and/or PTT applications. Their UV-Vis-NIR absorption, emission, and ns transient absorption characteristics were systematically investigated. Reactive oxygen species generation and photothermal effects for some of these complexes were studied as well. Preliminary in vitro and in vivo phototherapeutic effects on 4T1 cells and subcutaneous allograft 4T1 breast tumor have been demonstrated. In vitro light-dependent inactivation of Staphylococcus aureus was conducted as well.

Developing triatomic small molecules targeting solar UV-driven skin cancers

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Solar ultraviolet (UV) radiation is an established environmental carcinogen involved in the etiology of both nonmelanoma (NMSC) and melanoma skin cancers, relevant to sun-exposed populations in Arizona (high UV, 300+ sunny days) and worldwide. Based on pharmacokinetic versatility and unique molecular mechanisms of action, small triatomic molecules offer significant opportunities for cancer prevention and systemic therapy. For NMSC-prevention we have developed a topical molecular approach inducing cellular chlorination stress imposed by triatomic hypochlorous acid (HOCl), an endogenous electrophile and innate immune factor. In the SKH-1 high-risk mouse model of UV-induced human keratinocytic skin cancer, topical HOCl blocks inflammatory gene expression (Ptgs2, Il19, Tlr4) and tumorigenic progression, observations substantiated in a cutaneous human organotypic model. For therapeutic intervention targeting the advanced metastatic stage of melanoma skin cancer, we have developed a systemic intervention approach involving cellular deuteration by the triatomic water-isotopologue deuterium oxide. In mouse models of human metastatic melanoma, we have demonstrated efficacy of deuterium oxide-based induction of deuteration stress, a unique form of cellular proteotoxicity resulting from deuteron- (versus proton-) based disruption of hydrogen bond networks eliciting the cytotoxic ER stress response substantiated by gene expression array analysis. In mouse models of brain melanoma (murine B16, human A375), representing the hard-to-treat stage of intracranial metastasis, systemic administration of deuterium oxide induced rapid plasma and brain deuteration (confirmed by proton-MRI and isotope-ratio mass spectrometry), inhibiting tumor growth with prolonged survival. In summary, our observations suggest feasibility of triatomic molecular strategies translatable to prevention and therapy of solar UV-driven human malignancies.

AI-assisted evaluation of translational potential in photochemistry and photobiology

Shiyong Wu

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Abstract: Photochemistry and photobiology research frequently produces discoveries with potential applications in medicine, diagnostics, energy, and materials science, yet many promising advances fail to translate beyond the laboratory. A key challenge is not scientific creativity, but the lack of accessible tools for early, structured evaluation of translational potential by basic scientists. This presentation introduces a practical framework for using artificial intelligence (AI) as an assistive tool to evaluate whether and how basic photoscience discoveries might progress toward real-world applications. By integrating AI-guided analysis with simplified business strategy tools—such as the Business Model Canvas and lean business planning—researchers can systematically assess value propositions, potential users or customers, differentiation, key risks, and validation pathways without requiring formal business training.

The talk emphasizes conceptual frameworks and practical workflows rather than detailed case studies. It will illustrate how AI can help researchers reframe scientific findings in application-oriented terms, identify gaps or weak assumptions early, and prioritize experiments that strengthen translational relevance. This approach is intended to complement, not replace, scientific judgment, technology transfer offices, or industry expertise.

Overall, this presentation aims to provide photochemists and photobiologists with a low-barrier, structured method to think critically about translation at an early stage, improving communication with funding agencies, industry partners, and commercialization programs, while helping researchers decide which discoveries are best suited for further translational development.

Genome-wide maps of mutations and UV photoproducts induced by sunlight

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Exposure to the ultraviolet (UV) spectrum of sunlight is the primary etiological agent for skin cancers such as melanoma. While we and others have previously analyzed mutations and DNA photoproducts induced by exposure to artificial UV light in the laboratory, much less is known about the spectrum of mutations and photoproducts induced by direct sunlight exposure. Here, we exposed wild-type and repair-deficient yeast cells to 15 doses of one hour of direct sunlight over the course of ~1-to-2 months and identified the resulting sunlight-induced mutations by whole genome sequencing. Analysis of the resulting mutation data has revealed the roles of different DNA lesions and repair pathways in sunlight-induced mutagenesis. In parallel, we have used high-throughput sequencing methods to map the genome-wide distribution of cyclobutane primer dimers (CPDs), pyrimidine-pyrimidone (6-4) photoproducts, and atypical purine-containing photoproducts in cells and DNA following sunlight exposure. These findings have potentially important implications for sunlight-induced mutagenesis in skin cancers.

Yellow fluorescent protein: a protein qubit platform for future quantum technologies

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Quantum bits (qubits) are two-level quantum systems that support initialization, readout, and coherent control, playing a central role in all branches of "Quantum 2.0" technologies. Optically addressable spin qubits form the foundation of an emerging generation of nanoscale sensors. Exemplified by the legacy diamond nitrogen-vacancy qubit, researchers have achieved remarkable advances in high-precision quantum sensing for the life sciences, such as single-molecule EPR and NMR detection of proteins and nanoscale thermometry within subcellular organelles. However, current solid-state spin qubit platforms all face challenges in sample–sensor interfacing and exhibit performance heterogeneity, which limits their broader application in biological systems.

Yellow fluorescence protein (YFP) is a well-established molecular tool in biochemistry and biology. We recently reported that YFP can function as an optically addressable spin qubit. This discovery heralds the emergence of an entirely new class of genetically encodable, engineerable, and biocompatible quantum sensors for applications in life sciences, such as nanoscale field sensing and spin-based imaging. In this presentation, I will begin with a general introduction to quantum technologies and optically addressable spin qubits, followed by a discussion of the current understanding of the spin-coupled optical transitions in YFP and its qubit performance. I will showcase

the considerable potential for advancing key performance metrics and envision emerging applications of fluorescent-protein-based quantum metrology in the life sciences. I will also share my perspective on near-term research priorities and our ongoing work in this emerging area since the start of my independent career at Arizona State University.

Molecular mechanisms of spectrum tuning in far-red photoreceptor

Linta M. Biju[1], Zhong Ren[1], Anastasia Kraskov[2], Sepalika Bandara[1], Elham Norouzi Sardareh[1], Igor Shapiro[3], Peter Hildebrandt[2] and Xiaojing Yang[1]

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Cyanobacteriochromes (CBCRs) are bilin-binding photoreceptors of remarkable spectral versatility. Utilizing phycocyanobilin (PCB) as chromophore in a conserved protein signaling module, CBCRs regulate diverse light responses in cyanobacteria from photosynthesis to chromatic acclimation. Extensive structural and spectroscopic studies in the past decade have uncovered distinct molecular strategies underlying the spectral diversity in CBCRs. Our recent structure of a far-red-sensing CBCR, Anacy_2551g3, has revealed an unusual all-Z,syn PCB in the far-red-absorbing (Pfr) state, which challenges the widely accepted bilin coplanarity model for spectral tuning. In addition, Anacy_2551g3 photoconverts reversibly between the Pfr and orange-absorbing (Po) states with a significant spectral shift of 140-nm, offering a unique system for interrogating the molecular mechanisms of spectrum tuning in bilin-based photoreceptors. This work reports three crystal structures of Anacy_2551g3 representing the 15Z-Pfr, 15E-Pr, and 15E-Po states, respectively. These structures show that the Pfr/Po photoconversion entails ring D flipping but not bilin rotation. In this presentation, we will discuss the red-shift mechanism by examining the protonation states of Anacy_2551g3 using resonance Raman spectroscopy and quantum mechanics/molecular mechanics calculations. Our structural analysis has identified two sets of protein-chromophore interactions critical for the extreme red shift, underscoring specific roles of electrostatic effects on ring D in spectral tuning.

Molecular Design Strategy for Iridium(III)-based Photosensitizers to Enhance the Phototoxicity Index and Efficacy of Photodynamic Therapy

Gwangsu Yoon, Mingyu Park, Tae-Hyuk Kwon

Ulsan National Institute of Science and Technology (UNIST)

In photodynamic therapy (PDT), the phototoxicity index (PI) is crucial for evaluating photosensitizer (PS) efficiency, with dark toxicity lowering PI and increasing side effects. Ir(III)-based PSs effectively generate ROS, but some exhibit high dark toxicity, reducing PDT efficacy. Here, we propose a molecular design strategy to mitigate dark toxicity and enhance phototoxicity by modulating charge and incorporating organelle-targeting groups. Our results show that neutrally charged PSs exhibit lower dark toxicity than positively charged PSs, while organelle-targeting modifications enhance phototoxicity. This study highlights the importance of optimizing molecular charge and targeting properties to maximize PDT effectiveness.

Singlet oxygen-cleavable linkers for precision photodynamic therapy and controlled drug release

Youngjae You, PhD

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Singlet oxygen (SO)-cleavable linkers offer a powerful strategy for achieving spatiotemporally controlled drug activation in photodynamic therapy (PDT) and related photochemical applications. These linkers are designed to undergo selective oxidative cleavage upon exposure to SO, a reactive oxygen species generated by photosensitizers under light irradiation. In this presentation, I will describe the rational design and chemical tuning of SO-cleavable motifs, highlighting their stability under physiological conditions and rapid cleavage in response to photodynamically generated SO. Applications of these linkers in prodrug systems will be discussed, with a focus on targeted release of therapeutic agents in cellular and tumor models for treating local and metastatic tumors. The integration of SO-responsive linkers with modern PDT approaches provides a versatile and modular platform for precision photomedicine, minimizing systemic toxicity while enhancing therapeutic efficacy.

Understanding Photouncaging of Catechols

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Work in our lab has sought to demonstrate photocaging on different GPCR agonists. However, we've found that catechols make for poor targets of photouncaging. Our efforts to circumvent this challenge will be described, as well as the application of different photocaged catechol amines for the spatiotemporal activation of GPCRs.

Advances in photothermal therapy of hematological malignancies

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Hematologic malignancies are aggressive cancers that remain difficult to treat. Despite progress in chemotherapy, stem cell transplantation, and immunotherapy, many patients continue to face poor outcomes or relapse. There is a critical need for new treatment strategies that can more precisely target blood cancer cells while sparing healthy tissues. The use of noble metal nanoparticles such as gold nanoparticles enables enhanced tumor ablation due to their intrinsic high light-to-thermal conversion efficiency (photothermal effect). Photothermal therapy (PTT) is an emerging and promising cancer treatment modality harnessing light for therapeutic hyperthermia of solid tumors, but it is underexplored in blood cancers and there are currently no clinical trials evaluating the safety and efficacy of PTT for blood cancers. Photobiomodulation/PTT-based therapeutic platforms offer promising new avenues for the treatment of hematologic malignancies, which often present unique challenges in effective drug delivery and tissue targeting. Recent advances in this field demonstrate applicability across distinct disease contexts, including lymphoma masses that form well-defined, injectable lesions similar to solid tumor nodules, as well as malignancies dispersed within the bone marrow, where therapeutic access is inherently limited. In this presentation, we describe ongoing preclinical development efforts aimed at adapting photothermal strategies to these

diverse anatomical niches. These efforts underscore the critical role of interdisciplinary collaboration – integrating principles from engineering, targeted drug delivery, immunology, photobiology, and molecular precision medicine – in driving innovation. Ultimately, PTT-based therapies may enable a new class of precision interventions for blood cancers, with the potential to significantly improve treatment specificity, efficacy, and patient outcomes.

Photodynamic Therapy for Basal Cell Carcinoma in Clinical Practic

Nathalie C. Zeitouni MDCM, FRCPC

Medical Dermatology Specialists, University of Arizona COM Phoenix, Arizona

In clinical practice, patients often seek non-invasive options for the treatment of low-risk basal cell carcinomas (BCC). Previous reports have found a variability in photodynamic therapy protocols for BCC. The safety and efficacy of red-light PDT with 10% aminolevulinic acid (ALA) gel for superficial BCC was investigated in a recent phase III study. Of 187 randomized patients, histological and clinical clearance was 75.9 % and 83.4% with ALA gel vs 19.0 % and 21.4% with the vehicle (P <. 0001). Esthetic outcome was very good or good, and no unknown adverse reactions were noted. A separate study found that adding high-dose oral vitamin D to 20% ALA PDT increases the clearance rate of thin BCC. Combining PDT with hedgehog inhibitors has also shown promise in increasing the treatment efficacy for patients with multiple BCC.

Energy transfer from phycobilisomes to photosystems and its regulation

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Phycobilisomes (PBS) are the major light harvesting complexes in photosynthesis. While the PBS morphology is diverse, the basic architecture of PBS is conserved. We here report (1) the Cryo-EM structure of PBS from Synechococcus sp. PCC 7942, which contains a two-cylinder core and six rods. It is shown that ApcE is directly involved in the interaction between the core and the top two rods in the PBS with 2-cylinder core. We also determined the bundle-shaped PBS structure from Gloeobacter 7421 with Cryo-Em combined with mutagenesis analysis. (2) The attachment of PBS to PSII is studied and we show here that a small linker protein (LcpA) is required for such an attachment in the cyanobacterium Synechococcus sp. PCC 7002. We demonstrate that LcpA interacts with both CP47 of PSII and ApcB of PBS core. (3) We constructed a petB mutant, which lacks the petB gene encoding one of large subunits (PetB) of Cytochrome b6f (Cyt b6f) complex. The Cyt b6f complex absent in the mutant and state transitions that regulate light energy distribution between two photosystems were severely impaired, suggesting that the sensing of the imbalance of excitation between the two photosystems requires Cyt b6f complex. We also discuss the possible mechanism how excitation energy is transferred from PBS to PSI in cyanobacteria.

Heteroleptic Iridium Complexes show unmatched potency as antimicrobial photosensitizers for hard-to-treat bacterial and fungal infections

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Antimicrobial resistance is estimated to surpass cancer as a cause of mortality and be responsible for over 10 million deaths worldwide by 2050. Antimicrobial photodynamic therapy (aPDT) evades the development of resistance and has the potential to convert resistant into susceptible strains. However, aPDT has found limited translation into clinical settings. Here, we present metal-complex-based photosensitizers that show unmatched potency against hard-to-treat pathogens. The gram-negative Pseudomonas aeruginosa is classified as high-priority priority bacterial pathogen and is often associated with antibiotic resistance. The heteroleptic Iridium complex 3T-Ir inactivates about 7 log of P. aeruginosa with as little as 1 μM and 10 J/cm², being 100 times more potent than Rose Bengal (RB) in a direct comparison, and more potent than any other photosensitizer found in the literature. In biofilm conditions, as little as 10 μM and 10 J/cm² are sufficient to decrease viability by over 90%. And in a mouse model of skin wound infection, 3T-Ir not only outperforms RB, but the gold-standard antibiotic levofloxacin, in reducing infection burden. Candidozyma auris is an emerging multi-drug-resistant fungal pathogen, for which a similar 100-fold difference in potency to RB, and no match in the literature has been found for the complex 4T-Ir when in vitro. In such case, only 100 nM and 10 J/cm² are necessary, and these same conditions are sufficient to reduce viability by 80% in a C. auris biofilm. Overall, 3T-Ir and 4T-Ir show tremendous potential as aPDT agents and could help address the urgent need to overcome antimicrobial resistance.

Photoactivatable Platinum(IV) Complexes: Versatile Chemical Tools for Biomedical Applications

Yaorong Zheng

Kent State University

The Zheng lab develops photoactivatable Pt(IV) complexes as versatile chemical tools for biomedical research. This presentation highlights our efforts to engineer Pt(IV) complexes designed for efficient photo-uncaging using NIR light. Photo-uncaging enables spatiotemporal control over biologically relevant molecules by light-triggered cleavage of protective groups, allowing precise regulation of molecular activity. However, conventional photolabile groups typically require UV light, which suffers from limited tissue penetration and increased phototoxicity, restricting their biomedical applicability. To address these challenges, we have developed fluorophore-conjugated Pt(IV) complexes that undergo photoreduction upon NIR irradiation, enabling effective NIR-driven uncaging. These systems combine deep-tissue optical accessibility with modular chemical design, offering user-friendly and broadly adaptable platforms. Applications of these photoactivatable Pt(IV) complexes span controlled drug activation, molecular sensing, and spatiotemporally resolved chemical manipulation in biological environments.

Dynamics of mechanism of a dual function of DNA repair and signal transduction by CraCRY protein

Dongping Zhong

Center for Ultrafast Science and Technology, Zhang Jiang Institute of Advanced Study, Shanghai Jiao Tong University

The cryptochrome/photolyase family (CPF) is a group of structurally similar flavoproteins with distinct functions. The function of photolyases (PLs) is to repair DNA lesion caused by ultraviolet radiation. Cryptochromes (CRYs) exhibit various functions, serving as blue-light photoreceptors in plants and insects, regulating their growth and development. Most CRYs do not possess DNA repair functions. However, a recently discovered animal-like cryptochrome named CraCRY in Chlamydomonas reinhardtii functions as both cryptochrome and (6-4) photolyase, which can repair a type of DNA lesion caused by ultraviolet light, (6-4) photoproduct (6-4PP). The molecular mechanism by which CraCRY utilizes blue light energy to repair DNA lesion and form the initial signaling state remains unclear. Here, we used ultrafast spectroscopy and single-molecule methods to elucidate the dynamics and molecular mechanism of CraCRY. We elucidate the entire repair photocycle with femtosecond resolution and

the structural conformation of initial signaling with single-molecule detection. We also reveal the actual redox state for simultaneously maintaining the two functions, which is a hot debate of the key cofactor issue in the field.

DNA repair of 6-4 photoproduct by photolyase needs one- or two-photon excitation?

Dongping Zhong

Center for Ultrafast Science and Technology, Zhang Jiang Institute of Advanced Study, Shanghai Jiao Tong University

The molecular mechanism of repair of 6-4 pyrimidine primidone (6-4PP) in DNA lesion by photolyase (PL) has been in debate. The key question is whether the repair needs one or two photons excitation to reverse the damage to the normal bases. In our previous work, we reported one-photon excitation of the flavin cofactor to repair 6-4PP by At6-4PL photoenzyme and received significant attention. One critical argument is that two-photon excitation is necessary to completely repair 6-4PP. Here, we mapped out the entire repair evolution form femtosecond to millisecond for the previous At6-4PP and the recently discovered bifunctional CraCRY and unambiguously determined the repair only needs one-photon excitation. We captured all dynamics of the reactants, intermediates and the final products and measured all reaction timescales. These results revealed the final molecular mechanism of 6-4PP repair, similar to CPD repair, using one photon excitation to efficiently covert the damage to the normal bases.

Singlet oxygen dosimetry and light fractionation on PDT efficacy

Timothy C. Zhu, PhD

University of Pennsylvania

Photodynamic therapy (PDT) treats cancer through the interaction of a photosensitizer (PS), light, and oxygen. Direct detection of singlet oxygen (SO) is the gold-standard dosimetry for type II PDT, some SOLD methods are uniquely capable of continuous SO monitoring using the same continuous-wave (CW) PDT treatment light. This talk surveys quantitative dosimetry of 1O2 via singlet oxygen luminescence dosimetry (SOLD) in vivo, comparing SOLD with explicit singlet oxygen dosimetry (SOED) that uses explicit dosimetry of light fluence rate (ϕ), PS concentration ([PS]), and oxygen concentration ([3O2]), or SOLD-based approaches. Preclinical and clinical studies will be reviewed to illustrate the current state of the art in SOLD, including time-domain SOLD (TSOLD) and multi-spectral CW SOLD (MSOLD). Finally, fractionated PDT has been shown to improve long-term local control (LCR at 90 days) in vivo and to significantly reduce the threshold dose of [1O2]rx required for type II interactions.

Biocompa(bility of Non-Aqueous Solvents with Rhodobacter sphaeroides Chromatophores

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The urgent global demand for sustainable energy solutions has stimulated innovative research at the intersection of biology, photonics, and solar energy conversion. This work is embedded within the European APACE project, which aims to develop a bio-inspired sunlight-pumped laser system capable of directly converting diffuse natural sunlight into a coherent laser beam by exploiting the exceptional light-harvesting efficiency of bacterial photosynthetic antenna complexes.

The present study investigates the stability and functional integrity of photosynthetic chromatophores extracted from Rhodobacter sphaeroides in non-aqueous environment suitable for integration into the supramolecular gain materials envisioned by APACE. UV–Vis–NIR absorption spectroscopy was employed to monitor over time the effects of selected organic solvents and deep eutectic solvents on the characteristic bacteriochlorophyll absorption bands associated with the LH1 (~875 nm) and LH2 (~800 and 850 nm) complexes, thereby identifying conditions that preserve the native light-harvesting properties required for efficient solar energy capture and transfer. The results demonstrate that selected co-solvents preserve chromatophore spectral integrity, with deep eutectic solvents exhibiting particularly promising stability profiles. These media may enable long-lived functional environments for sunlight-pumped lasing applications. Overall, this study advances the understanding of how bacterial photosynthetic units can be stabilized within engineered materials, representing a crucial step toward the realization of the APACE goal of developing sunlight-pumped laser devices operable under unconcentrated solar illumination.

Optogenetic control of biological processes: from photoreceptor engineering to their implementation in microbial, animal and plant systems

Matias Zurbriggen

Institute of Synthetic Biology and CEPLAS, Heinrich-Heine-Universität Düsseldorf, Germany

The development of a functionally different set of optoswitches has taken root and expanded the applicability of light as stimulus to control a plethora of cellular processes. These range from gene expression, protein stability, receptor function, subcellular localization of proteins and organelles up to the generation of biohybrid materials to manipulate extracellular environments and regulate cell viability. We discuss here representative examples of the whole synthetic biology research process leading from the engineering and rewiring of the photoreceptors for the intervention of the molecular and cellular processes up to their application in vivo. We describe a wide family of tools sensitive to different wavelengths of the white light spectrum, namely UV-B, blue, green, orange, red/far-red. With hundreds of engineered photoreceptors and optoswitches being reported, we have now entered an era in which we can combine different systems to achieve orthogonal, independent control of various cellular processes using light of different colors sequentially or simultaneously, transitioning from 2D to the 3D spatial control. We implement these molecular tools into microbial, yeast/fungi, mammalian cells, and in vivo in animals. We have successfully introduced optogenetic into plants, by overcoming the intrinsic experimental limitations posed by the need of plants for light to grow. We use optogenetics to precisely control metabolic and signaling networks, and introduce novel functionalities in the organisms. These synthetic biology strategies open up unforeseen perspectives in fundamental and applied research, including the biomedical and biopharmaceutical fields and crop improvement.

NOTES

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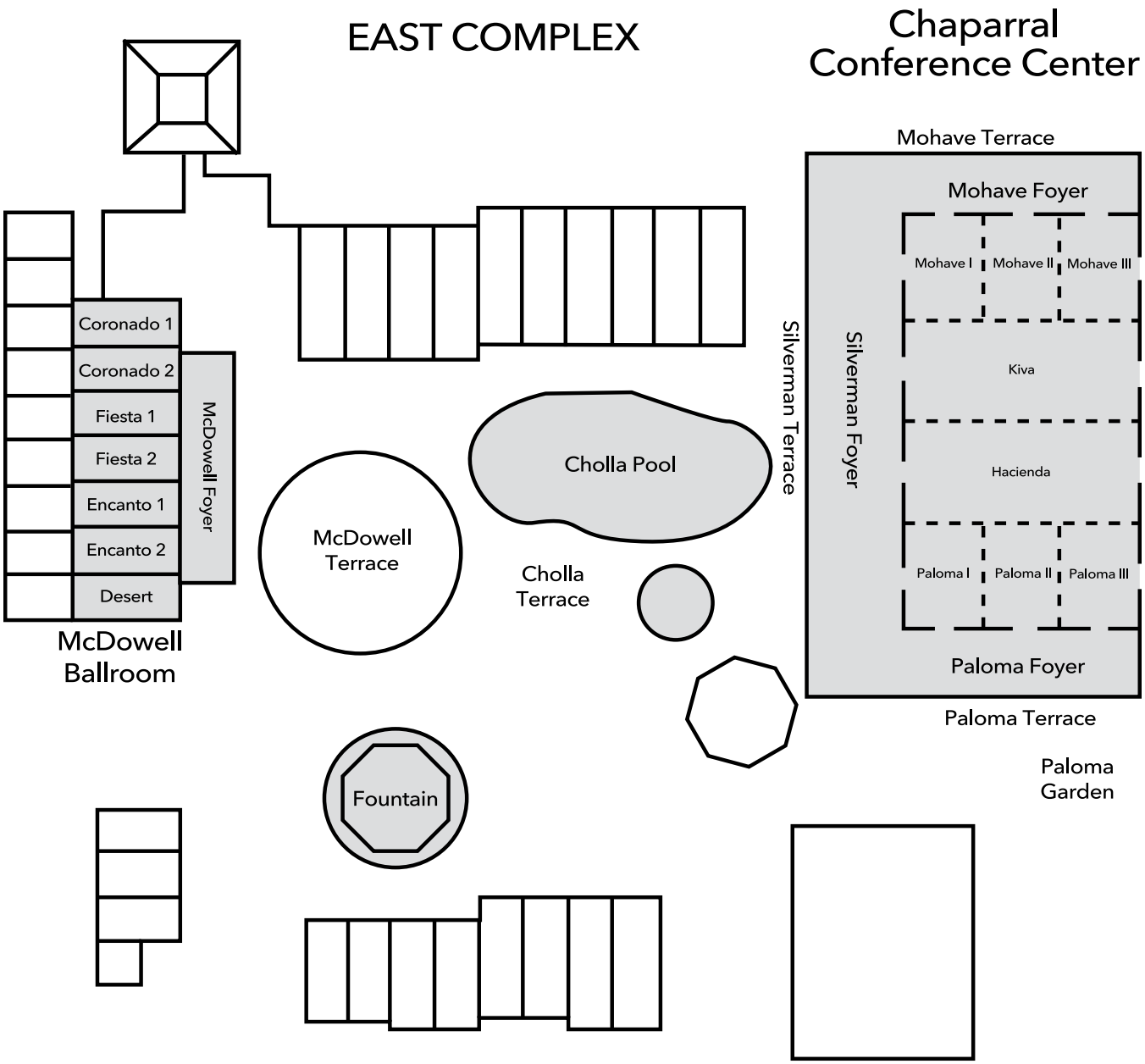

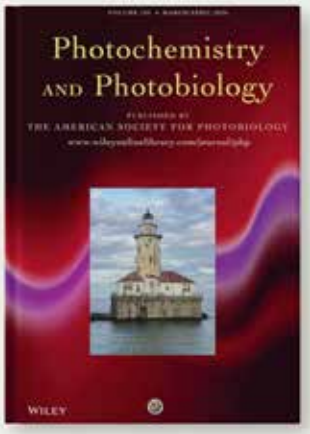

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